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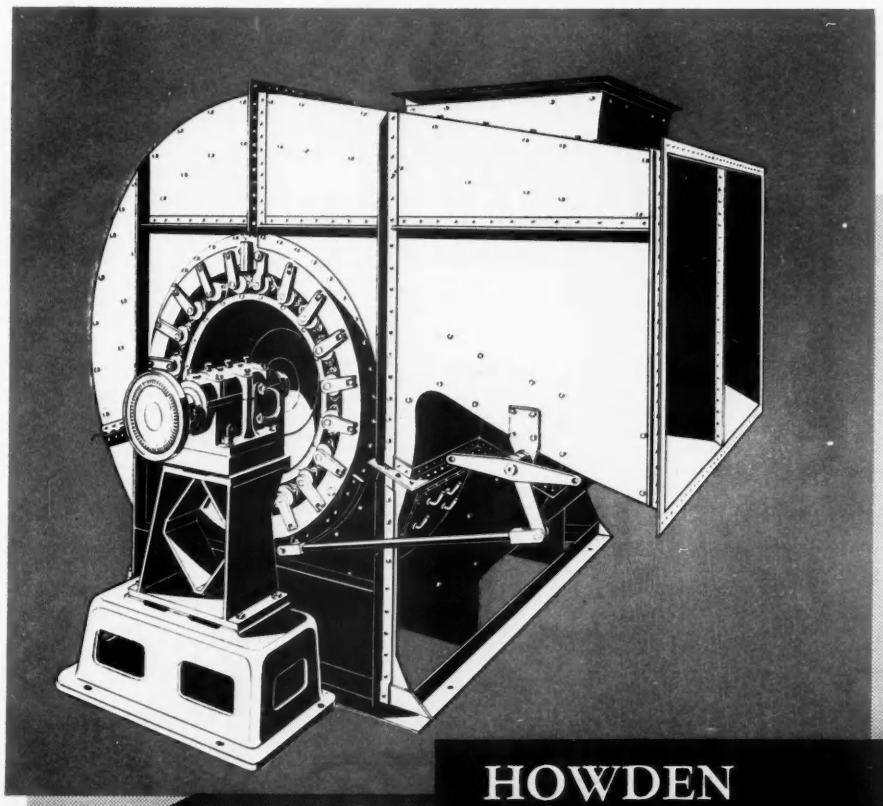

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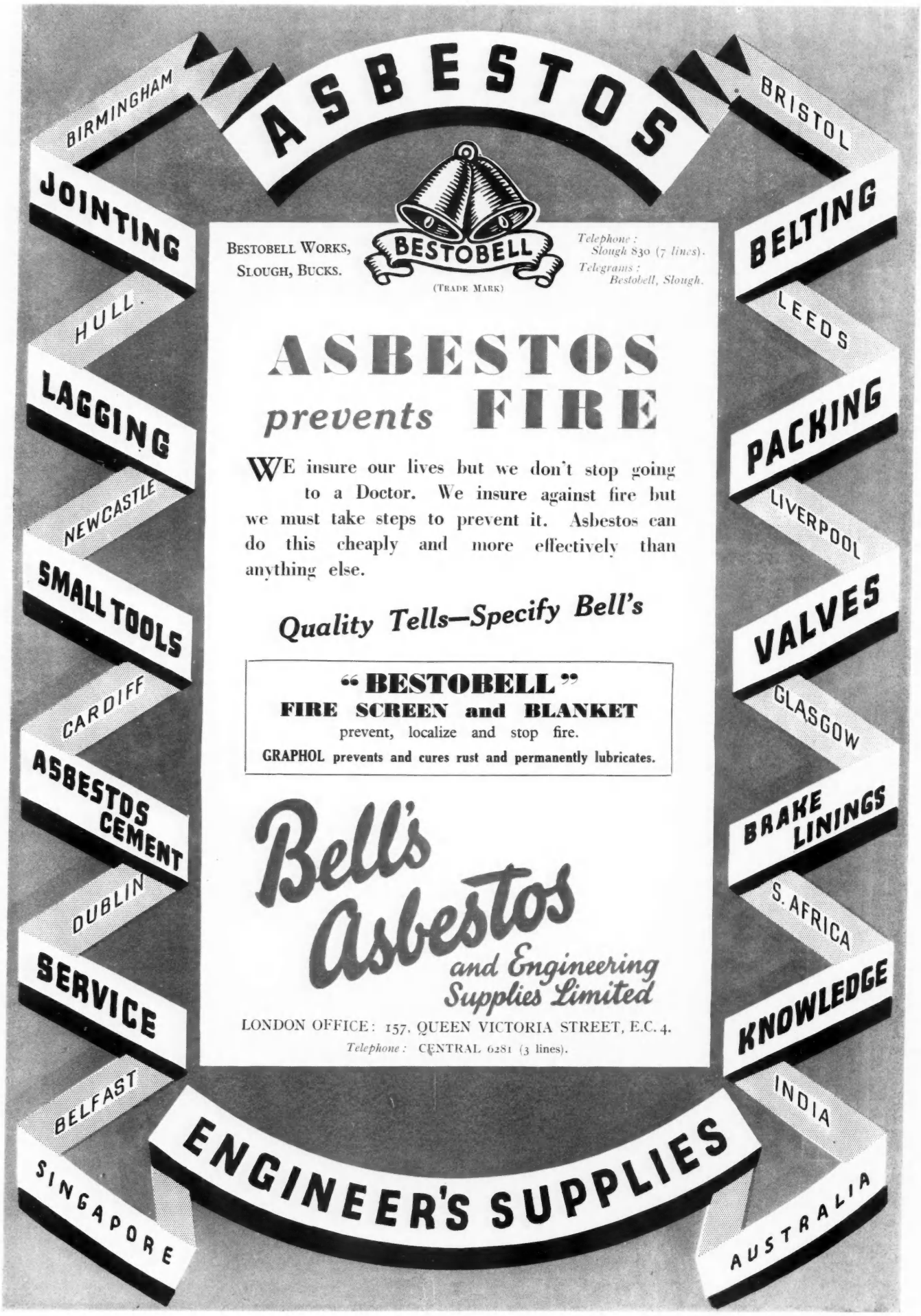
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A Seven-Day Journal

Safety in Mines.

Two important papers bearing upon coalmining accidents have just been issued by the Safety in Mines Research Board. One deals with the Ignition of Firedamp by Broken Electric Bulbs. It is found that ignition of firedamp can be caused under certain conditions by the heated filament after fracture of the glass bulb, and in certain instances in this country and abroad an electric safety lamp has been suspected of having caused an explosion in this way, but there has usually been insufficient evidence to justify any definite decision. Experiments have been carried out by the Board to ascertain whether it is possible to determine, from the appearance of the filament of a broken electric lamp bulb, whether or not it has been burned out in a firedamp-air mixture, and may therefore have originated an explosion. As a result of the investigation, it has been concluded that the colour of the filament, which is affected by any oxidation of the metal, is an important factor in attempting to determine under what conditions a bulb was fractured and that it may sometimes be possible from an examination of a broken lamp to judge whether or not the filament had burnt out in an explosive mixture and had thus been a potential source of ignition. The other report is concerned with the Ignition of Firedamp by Coalmining Explosives. In a former report, issued in 1931, the results of general research over a number of years into the safest methods of using explosives in coal mines, including such matters as the choice of shot hole, weight of charge, position of the detonator, and quantity of stemming, were summarised. The present report gives an historical review of experiments by Watteyne, Lemaire, and other workers on the use of cooling salts and special methods of stemming for the prevention of firedamp ignitions from shot-firing, and presents a full account of later work in Belgium and this country on the development of a sheath for explosives which is convenient to use, and so far increases the safety during shot-firing as to prevent the ignition of firedamp by a blown-out or overcharged shot of a permitted explosive. Experimental work has shown that sodium bicarbonate is an effective and practicable sheathing material, and explosives so sheathed, when tested under mining conditions, have been proved to perform their work equally as well as the corresponding unsheathed explosives.

Overtime in Industry.

IN the course of an address given to the Leeds Chamber of Commerce at its annual dinner, held on Saturday, January 19th, Mr. Oliver Stanley, the Minister of Labour, referred to the conference to be held during the present week between himself and the National Confederation of Employers and the Trades Union Congress, at which, he said, problems of employment would be discussed. Among other questions to be dealt with was, the Minister said, that of overtime in industry. It must be recognised, he pointed out, that there were emergencies in which overtime was the only possible way by which an order could be secured, and production accomplished. What was wanted, he suggested, was to examine the possibilities of those occasions when overtime might quite well be avoided, especially when it was not the result of sudden and unavoidable pressure of work, but of indifference to the possibility of extending employment to others. If an appeal to the producer about overtime was to be made, then an appeal to the buyer should also be made, for by that means a great deal of unnecessary overtime might well be avoided. Another important question which in the future would, he thought, become more acute was the question as to whether the supply of skilled workers in industry generally was sufficient to meet any sudden trade revival. In not a few industries there were, he said, signs that if a revival came, a certain scarcity of skilled workers would at once become apparent. What steps, Mr. Oliver Stanley asked, were now being taken to ensure that when a revival came we should be in a position to take full advantage of it?

River Trent.

THE first triennial report of the River Trent Catchment Board has just been issued. It deals with the activities of the Board during the period from its constitution on May 13th, 1931, to October 31st, 1934, being the period of the first three years of its statutory existence. In a Foreword the Chairman of the Board, Captain H. FitzHerbert Wright, says that in drawing up this report—the first of an intended series of triennial reports—the Clerk and the Engineer have, at his request, included in it much information in connection with the Board's activities during the last 3½ years and also in connection with the Land Drainage Act, 1930, the constitution of the Board, its duties and responsibilities, its "main river," and the catchment area over which it exercises its jurisdiction. This has been done with intention, and in the hope that so comprehensive a survey may be useful to the members of the Board, their successors, and to their constituent authorities. In presenting this report, with the authority of the Board, he reminds its readers that during the Board's short life extremes of flood and drought—three floods, one of them exceptional, and a prolonged drought through most of 1933 and 1934—have been experienced throughout the catchment area, causing widespread damage, loss, and inconvenience in many ways and to many people. At so early a stage of its existence, obviously, the Board was in no position to take effective remedial action; the most it could do was to collect and register records from various points on the "main river" for subsequent use in the preparation of schemes so shown to be necessary for flood prevention or flood alleviation, and to take serious notice of the warning conveyed by the prolonged drought that, side by side with all such schemes or as part of them, provision for the storage and conservation of water must not be left out of consideration. Within the last few days the Government has decided to set up a committee of inquiry into the country's water resources and their supply. It may be that, as a result of this inquiry, in order to avoid conflict between water authorities and the multiplication of such authorities, the Board, in common with other catchment boards, may be called on to undertake additional duties and responsibilities. He adds that he can see the possibility that the ultimate result of the Board's "constant aim," may be the realisation in due time of the ideal already attained by Father Thames and his Conservancy Board—One "Main River," One Authority.

An International Shipping Conference.

THE preliminary Conference on Rationalisation of Shipping concluded its London deliberations on Friday, January 18th. A draft scheme has been prepared for submission to the national association in the countries represented without in any way committing them in the meantime, and certain alternative suggestions made by some countries will be the subject of careful study by the secretariat. It is understood that the scheme prepared will follow on general lines the Schierwater plan for oil tankers, and that all freight tonnage, with the exception of tankers, refrigerated ships, coastal, and fishing vessels, will be included in it. In a statement on the general work of the Conference made on Monday last in Liverpool, Mr. Lawrence Holt, of the Blue Funnel Line, said that the scheme produced by the preliminary Conference was the outcome of general and generous effort by those representing the international shipowning community. All present, whether agreeing or disagreeing with the policy of international action, tried their best to contribute to the preparation of a working scheme. The scheme was based upon the motive of economic attraction, freed from any element of compulsion other than the compulsory payment of contributions. Whether it was wise or practicable, he proceeded, thus to make a substantial levy upon ship tonnage engaged in the international cargo-carrying trade for the purpose of raising rates of freight to an economic level by inducing financially the laying-up or scrapping of tonnage, was a matter of high policy requiring grave consideration from many points of view.

The Dartford Tunnel Scheme.

AT a conference of Thames-side interests held in November last, an effort was begun to reopen and carry forward the proposal to build at a cost of about £3,000,000 a tunnel under the Thames between Dartford and Purfleet. The sub-committee appointed by the conference met on Monday, January 21st, at Bush House, under the chairmanship of Mr. E. Hanford, the Chairman of the Purfleet Urban District Council. Mr. Hanford stated that a letter had been received from the Minister of Transport in which Mr. Hore-Belisha said that he had carefully noted the views expressed at this conference, and was himself fully alive to the importance of the project. At his request a report had been only recently furnished by the London and Home Counties Traffic Advisory Committee, on which the County Councils of Essex and Kent were represented. When Mr. Hore-Belisha has had an opportunity of examining this report and other aspects of the matter, he will consider whether he could usefully trouble a deputation to attend Whitehall Gardens and will communicate again with the sub-committee. The sub-committee decided to invite Members of Parliament for the constituencies specially interested to meet the committee at the Houses of Parliament to discuss what steps can be usefully taken to expedite the scheme. Mr. Hanford further stated that it was understood that the report of the Traffic Advisory Committee favoured the construction of the tunnel, and he was informed that the tunnel had been given first place on the Committee's list of schemes.

Metals in the Food Industry.

A PAPER of considerable interest to all concerned with the manufacture of food was read by Mr. N. D. Sylvester, at a meeting of the Birmingham and Midland Section of the Society of Chemical Industry at Birmingham University on January 21st. "The food chemist," said Mr. Sylvester at the commencement of his paper, "is as jealous of the purity of his product as the chemical manufacturer is of the purity of his fine chemicals, and one of his primary considerations must be the suitability or otherwise of the metals at his disposal." In considering the suitability of a metal for a food process, he went on, there were three things to be considered. The first was the effect of the metal on the food and the amount of metallic contamination; the second was the effect of the food on the metal, and the third was the effect of washing and cleansing solutions on the metal. The action of washing and cleansing substances on the plant was of great importance and was often more serious than the action of the food. The metallic contamination of the food was, of course, a matter of primary importance, and so far as possible it should be reduced to a minimum. Quoting a number of examples of foods affected by different metals, Mr. Sylvester said it was interesting to note that the presence of 1 part of copper in 40 million parts of butter had recently been shown to have a marked effect on the keeping properties of the butter. The presence of copper in milk was one of the causes of the development of tallowy flavours, and iron showed a similar, but less marked, influence. Among the more important factors influencing the extent of the corrosion of metals by foods were: Temperature, time of contact, presence or absence of air, formation of protective films derived either from the food or from the metal—which might protect the food from contamination or the metal from further corrosion—and lastly, the cleanliness of the plant. Iron and mild steel were the widest used metals in the food industry as in most other industries, especially for machinery parts with which food did not actually come into contact. The modern tendency, which gave improved performance, was to modify the iron and steel by the addition of other elements. Mr. Sylvester said he was not aware that chromium-plating had found an appreciable use in the food industry, but if the quality could be improved to the present reliability of, for example, nickel-plating, it should have many applications. "I would in conclusion remind you," remarked Mr. Sylvester at the end of his address, "that this subject is one on which it would be foolish to be dogmatic. The corrosion resistance of metals in practice is not always that which would be expected, and it sometimes happens that a metal is satisfactory in one case, but not in a second when conditions were thought to be identical."

Railway Wages.

WE are pleased to be able to report that on Tuesday, January 22nd, the special joint committee appointed by the four railway companies and the three railway trade unions, to consider the future form of negotiating machinery for the railways, has decided unanimously to recommend the adoption of a scheme which, by a modified form of procedure, should work more smoothly than that which was brought to an end by notice last March. The most important feature of the new scheme is the creation of a Railway Staff National Council, consisting of eight representatives of the railway companies, four representatives nominated by the National Union of Railwaymen, two nominated by the Associated Society of Locomotive Engineers and Firemen, and two by the Railway Clerks' Association, which will replace the former Central Wages Board. If the National Council fails to secure a settlement of any dispute referred to it, a second new body, known as the Railway Staff National Tribunal, will be asked to intervene. This tribunal will consist of an independent chairman and two independent members, one nominated by the companies and the other by the unions.

Worshipful Company of Shipwrights.

FROM the 'seventies of last century until 1918, the Department of Science and Art, South Kensington, held an examination annually, and awarded medals on the results to candidates drawn from students at evening classes in naval architecture throughout the Kingdom. For various reasons these examinations ceased in 1918. Later the Worshipful Company of Shipwrights decided to revive the examination and the award of medals, and, accordingly, regulations were prepared for the conduct of the examination, but, owing to the depression in the shipping industry, there were never sufficient candidates to warrant the holding of this special examination. The regulations laid down that six students who had obtained the Senior National Certificate in Naval Architecture were eligible, and in 1933 nine students gained this distinction. Accordingly, six of these nine who had obtained the highest percentage of marks were invited to come to London to sit for the examination, return railway fare and a subsistence allowance being provided for each candidate. The examination took place in December, with Dr. J. J. Welch as official examiner. He set the papers, selected the subjects for the essay, and conducted the *viva voce* examination on the first day. On January 17th, the report of the examiners was submitted to the Education Committee of the Worshipful Company, which made awards as follows:—To Mr. Forsyth and Mr. Walker, of Sunderland Technical College and the Royal Technical College, Glasgow, respectively, who were bracketed equal, Gold Medals; to Mr. Cook a Silver Medal, and to Mr. Naisby a Bronze Medal. Both of these candidates were educated at the Sunderland Technical College.

The Development of Parsons Industrial Turbo Machinery.

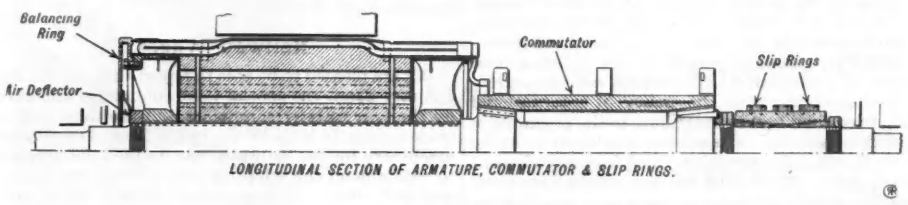
No. III.

(*Continued from page 64, January 18th.*)

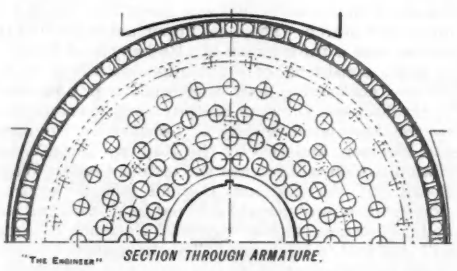
Double-current Generators with Automatic Brush Rocking Gear.

AN interesting example of electrical engineering at the close of the last century is presented by a pair of turbo-generators built by C. A. Parsons and Co. in 1900, to the order of Messrs. Christy Brothers and Middleton, of Chelmsford. The turbines, which were designed for a steam pressure of 140 lb. per square inch, were of the standard construction for those days and need not therefore be further referred to. The generators, however, were out of the ordinary in several respects, for they were not only required to provide both direct and alternating current, but were fitted with gear for automatically adjusting the position of the brushes in accordance with the load.

Each generator had a normal output of 500-kW at a speed of 1800 r.p.m. The fields were of the four-pole type, and the rotating armature was connected both to a commutator and a set of three-phase slip rings. From the commutator, direct current at 200 volts could be taken, while the slip rings supplied three-phase current at 60 cycles and about 113 volts. The design of the armature, commutator and slip rings is shown in Fig. 20. The armature, which was 29·625in. in overall diameter, had a smooth core with four rows of axial holes for ventilation. The windings were laid round the periphery and were spaced with wood packings, the whole being bound round with wire to withstand the centrifugal forces. Radial ducts near each end were provided to assist the ventilation, these ducts not being covered by the binding wire, which otherwise extended from end to end of the armature. Brass spiders supported the end windings, and the balancing ring at one end was fitted with deflector plates to direct the air through the windings.



LONGITUDINAL SECTION OF ARMATURE, COMMUTATOR & SLIP RINGS.



"THE ENGINEER" SECTION THROUGH ARMATURE.

FIG. 20—DOUBLE CURRENT GENERATOR—1900

The commutator was of the shrunk ring design. Heavy steel rings shrunk on over mica bushes held the segments together, and the whole commutator was supported on brass cones at each end. One of the cones was mounted on a feather, so that it would slide longitudinally on the shaft and accommodate its position to the expansion and contraction of the commutator caused by temperature changes. The method adopted for the construction of the commutator is worthy of mention. The bars, with their mica insulation between, were first assembled and held together temporarily by binding wire or clamps. The mica insulation for one of the steel rings was then built up in position by slipping pieces of mica leaf underneath an india-rubber band round the commutator. When the required thickness had been reached, a string was tied round the mica and the band removed. The steel ring, at red heat, was then threaded over the commutator and held in place over the layer of mica. As it contracted in cooling, it burnt away the string, and gripped the mica so tightly that it was a comparatively easy matter to turn the edges of the latter flush with the ring.

The three slip rings from which the output of alternating current was taken were held by screws on a wooden sleeve which was built up in sections and fixed to the shaft by cones and keys. Brushes of brass wire, covered with gauze, were used to collect the current from both slip rings and commutator. With such brushes the sparkless collection of the continuous current was not easy, and in the early dynamos with no commutating poles the distortion of the magnetic field by the armature current was so great in general that it was impossible to operate the machine with a fixed brush position at all loads. Consequently it was the practice for the attendant to move the brushes forward or backward by hand as the load increased or decreased, so as to keep them working in the neutral position on the commutator. The amount of movement necessary to do this throughout the whole range of load amounted to as much as 20 or 25 electrical degrees. This work required constant attention when the load was variable, and to relieve the attendant of the duty, Messrs. Parsons devised an automatic brush-shifting gear, which was fitted to the two machines supplied to Messrs. Christy Brothers and Middleton.

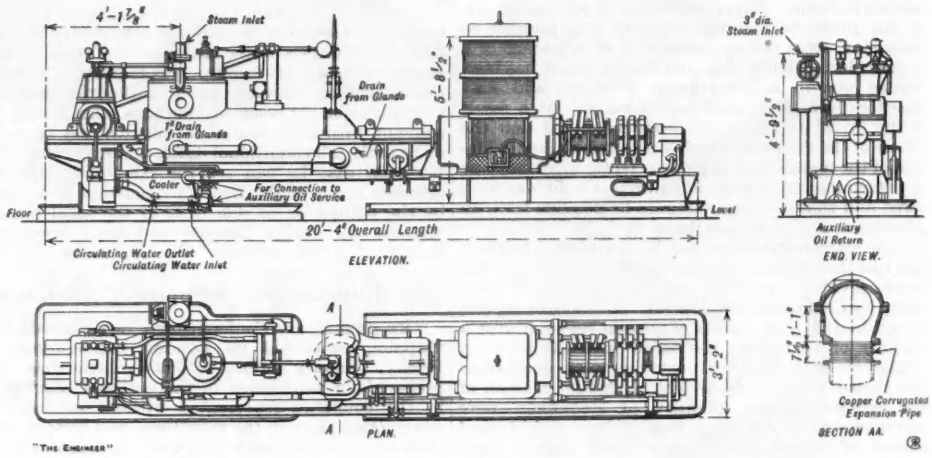


FIG. 22—DOUBLE CURRENT GENERATOR FOR SOUTH AFRICA—1901

The action of this gear depended upon the fact that the angular movement required for the brushes was very nearly proportional to the load on the machine, while the steam pressure at the inlet to the turbine blading was also approximately proportional to the load. The mechanism employed is illustrated in Fig. 21. A small vertical steam cylinder was set in the foundations at the end of the machine, and its piston connected by a rocking shaft and levers to the movable ring carrying the brush holders. A section through the cylinder is shown in Fig. 23. Steam at the pressure existing below the governor valve at any time was admitted beneath a spring-loaded piston. Any variation in the pressure of this steam thus caused the piston to rise or fall, and thus to change the angular position of the brushes around the

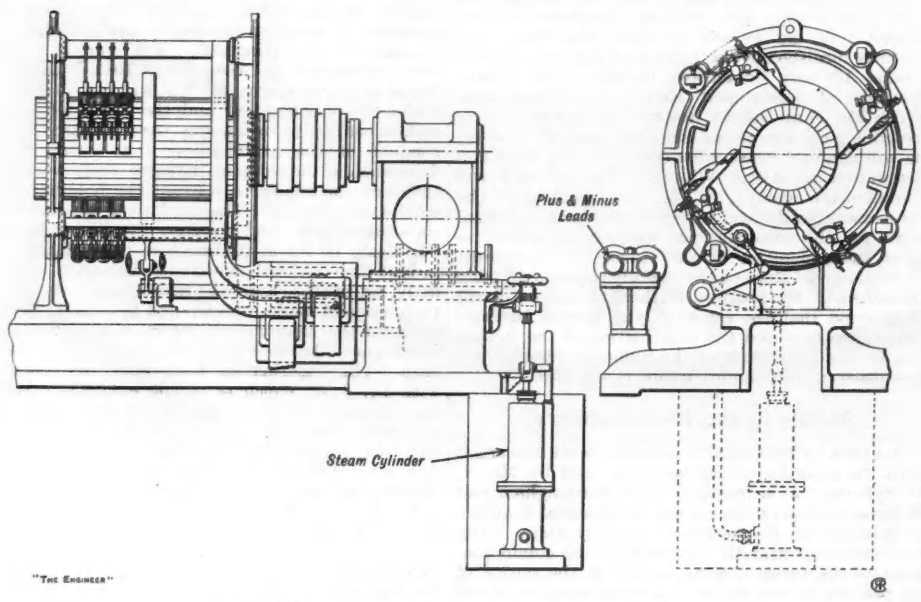


FIG. 21—AUTOMATIC BRUSH ROCKING GEAR—1900

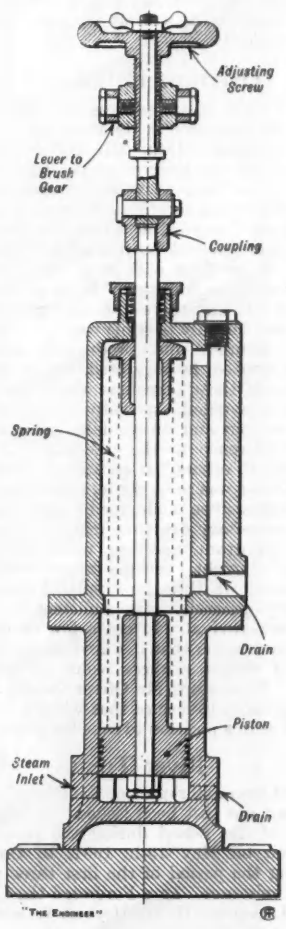


FIG. 23—STEAM CYLINDER FOR BRUSH ROCKING GEAR

commutator. A small hand wheel and screw interposed between the piston and the lever system permitted the adjustment of the brushes independently of the steam pressure when necessary. Any steam leaking past the piston was led away to a drain, while as a further precaution against the escape of steam into the atmosphere the piston-rod was kept steam-tight without appreciable friction, both by a spring gland and by the action of the abutment of the main

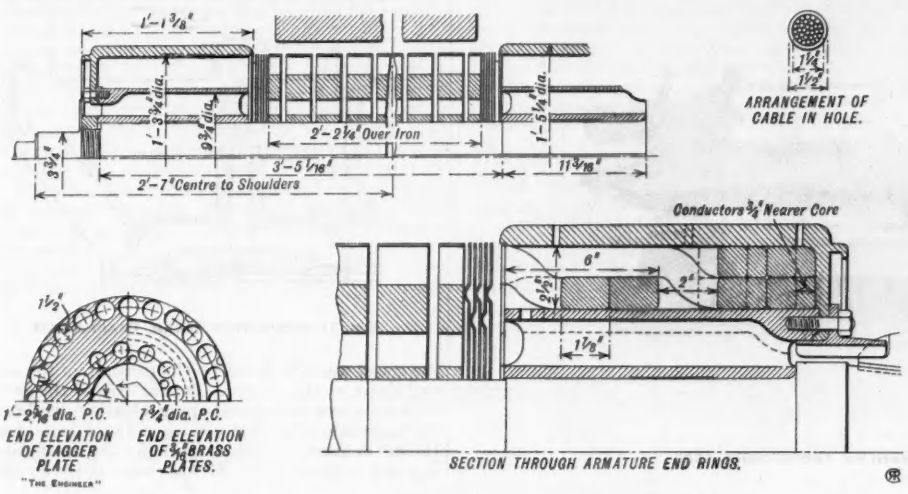


FIG. 24—ARMATURE OF DOUBLE CURRENT GENERATOR—1901

controlling spring. These had, of course, only to prevent the escape of steam at atmospheric pressure.

The machines supplied to Messrs. Christy Brothers and Middleton were not the very earliest to be fitted with the automatic brush-adjusting gear, for this had been first used on a 150-kW turbo-dynamo supplying power to the Heaton Works. The apparatus worked fairly well, but the mechanism was not quite rapid enough in its action to deal effectively with the instantaneous change in commutating conditions brought about by sudden and large changes in the load.

TANDEM AND DOUBLE-CURRENT UNITS FOR SOUTH AFRICA.

Soon after the construction of the double-current machines which have been described, several other interesting turbo-generators were built at Heaton. Amongst these was a 50-kW unit consisting of a turbine driving two 25-kW direct-current generators in tandem at a speed of 4000 r.p.m. The generators were arranged for operation either in parallel or in series, the voltage of supply being 220 in one case and 440 in the other. The set worked with steam at 120 lb. pressure and exhausted to atmosphere. It was supplied to the order of the Cape Peninsula Lighting Company, of Cape Town, in 1901, and had the distinction of being the first turbo-generator to be installed in South Africa.

In the same year three 135-kW sets were ordered by the same company. The first of these generated three-phase current at 60 cycles and 3300 volts. The other two were notable as being double-current machines, producing continuous current at 530 volts and three-phase current at 60 cycles and 300 volts. All three generators were of the same general construction, with horseshoe field magnets and rotating armatures running at 3600 r.p.m. The fields of the double-current machines were shunt wound, while those of the alternator were separately excited.

The turbines of all three sets were of identical design, operating with steam at a stop valve pressure of 150 lb. per square inch and exhausting into condensers. The arrangement of the double-current units is illustrated in Fig. 22. It will be observed that the auxiliary solenoid governor, usually mounted on the top of the field magnets of the machines of the period, has been discarded and replaced by a dash-pot and regulating spring on the exhaust end of the turbine. The steam relay, as used on previous machines, has been, however, retained. The turbine was provided with two centrifugal governors, the spindle of each being driven by bevel wheels from a cross shaft driven, in turn, by worm gearing from the turbine shaft. One end of the cross shaft carried a crank for working the main lubricating oil pump, while at the other end was a cam from which the steam relay received its jigging motion. One of the governors was the runaway governor, and was connected by a series of levers to the runaway valve, through which all steam had to pass before entering the turbine. The function of this governor was to shut the turbine down entirely in case of a predetermined overspeed being exceeded. The other governor controlled the speed of the machine under normal conditions by suitably altering the position of the fulcrum of the steam relay. The position of this fulcrum, and therefore the speed of the turbine, could also be adjusted by hand, by changing the tension of the regulating spring provided for this purpose. The runaway governor valve and the ordinary governor valve were both contained in the steam chest mounted on top of the turbine.

Details of the construction of the double-current armature are given in Fig. 24. The core was built up of paper-insulated laminations punched with a row of holes for axial ventilation, and separated by a number of spacers to permit of the radial flow of air. The windings were threaded through twenty-four totally enclosed circular slots punched close to the periphery of the stampings, each slot containing twenty-six conductors. The arrangement afforded great security against the effects of centrifugal forces on the conductors, and equal care was taken to resist the forces on the end windings. These were supported on brass end rings, and covered in by strong caps of the same material. Air circulated beneath the end windings for cooling purposes, and for the same reason a set of spun brass discs was mounted on the shaft at each end of the core. These discs were spaced axially by annular ridges formed in them, as shown in the illustration.

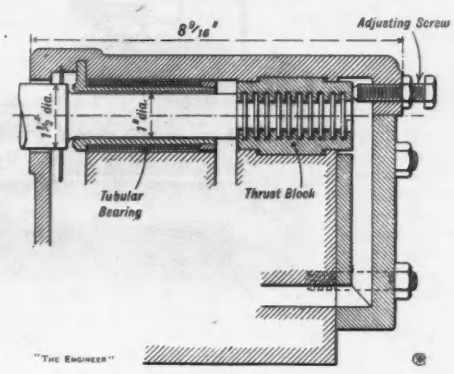


FIG. 27—BEARING AND THRUST BLOCK

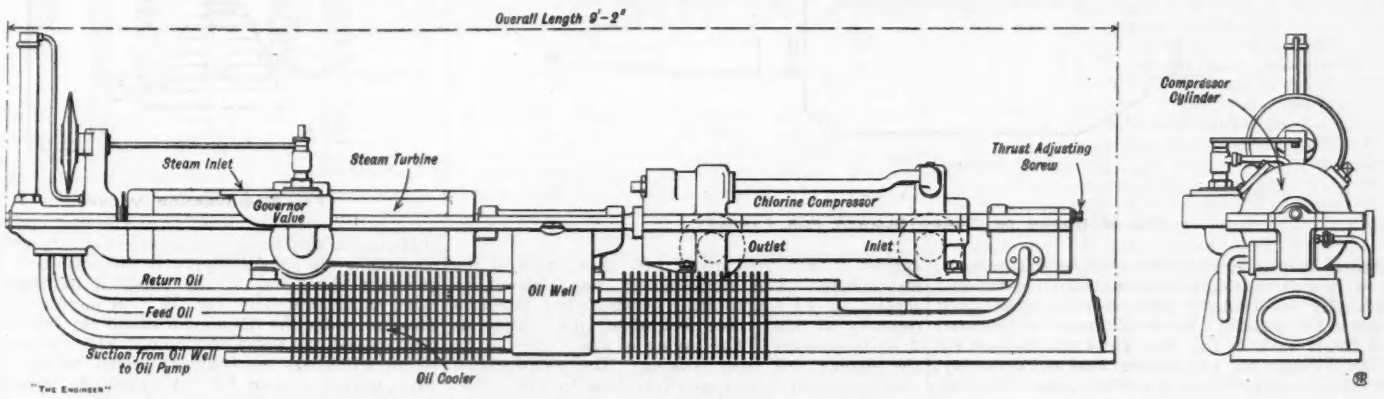


FIG. 25—SMALL TURBO-COMPRESSOR FOR CHLORINE—1902

A TURBO-COMPRESSOR FOR CHLORINE GAS.

Returning now to the development of turbo-compressors, a machine of a very unusual kind was ordered from Messrs. Parsons in 1902 by the Phœnix Process Trust Company, Ltd., of London. This was a turbine-driven compressor for dealing with chlorine gas. The machine was required to deliver 140 cubic feet of this gas per minute at a pressure of 10 lb. per square inch. The output being so small, a speed as high as 12,000 r.p.m. was decided on, and since the turbine was only required to develop a few horse-power, the steam end of the unit was reminiscent of the practice in the earliest years of the steam turbine. The design, indeed, as will be gathered from the general arrangement of the plant illustrated in Fig. 25, was almost exactly the same as that of the pioneer turbine of 1884. The rotor was of the original double-flow type, the steam entering at the centre and exhausting at both ends, and governing was effected by a rotary valve connected to a leather diaphragm which moved under the influence of the greater or less vacuum created in a chamber by a fan mounted on the turbine shaft. This, it will be remembered, was the method adopted for governing the first steam turbine ever made. The reason why a turbine of so early a type was fitted to the compressor was that such a turbine could be supplied very quickly, and the contract called for the delivery of the complete unit within four months of the receipt of the order, at a time when the capacity of the works was severely taxed. Moreover, for the duty that it had to perform, the turbine in question was entirely suitable, and known by long experience to be reliable.

The rotor of the compressor consisted of a central forging, 5·5in. in diameter, into which the stub

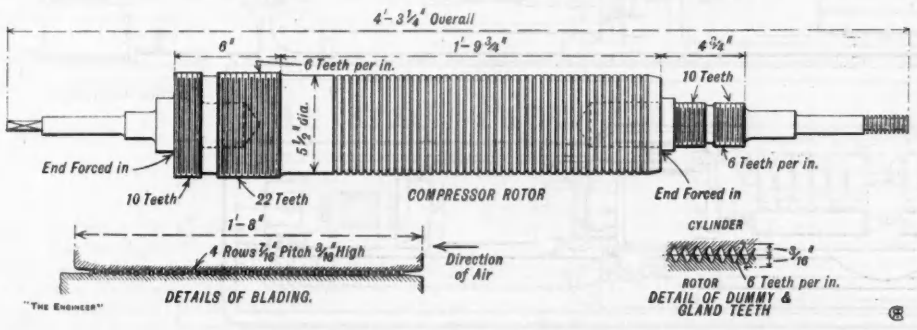


FIG. 26—ROTOR FOR CHLORINE COMPRESSOR

end shafts were forced. It is illustrated separately in Fig. 26. It carried forty-one rows of running blades all 0·187in. high, alternating with an equal number of rows of blades in the casing. The blades, as well as the caulking pieces which held them, were of mild steel. The design of the blading was the same as that adopted for the turbo-compressor exact location of the rotor in the axial direction. Fig. 27 shows the arrangement of bearing and thrust block.

TURBO-BLOWER FOR THE FARNLEY IRONWORKS.

The first application of the turbo-blower to blast-furnace work was made in 1902, when a machine of

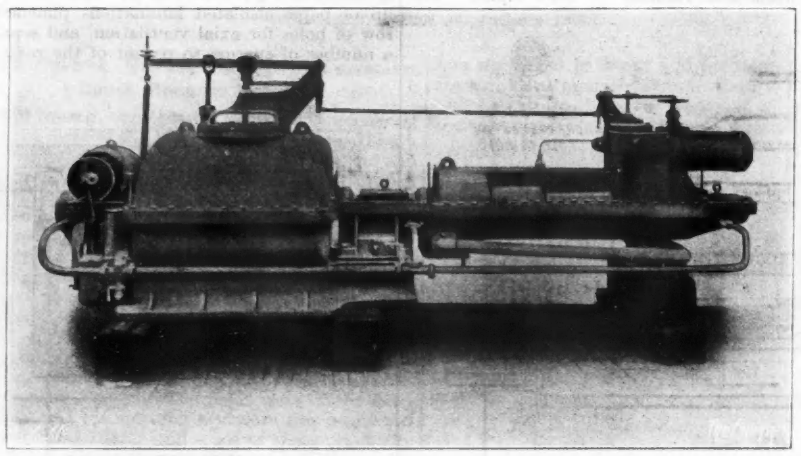


FIG. 28—TURBO-BLOWER AT FARNLEY IRONWORKS—1902

built the year before for Messrs. Cookson and Sons, and illustrated in Fig. 19. The fixed blades were parallel to the axis of the machine and acted merely as guide blades, the running blades behaving as fans. The dummy piston to balance the end thrust is hardly recognisable as such, for its diameter was only $\frac{3}{16}$ in. greater than that of the rotor. To secure gas-

the kind was constructed by Messrs. Parsons for the Farnley Iron Company, Ltd., of Leeds. This blower was designed to deliver 10,000 cubic feet of free air per minute at a gauge pressure of 3 lb. per square inch when running at a speed of 5200 r.p.m. It was driven directly by a steam turbine working with steam at 50 lb. per square inch, and exhausting

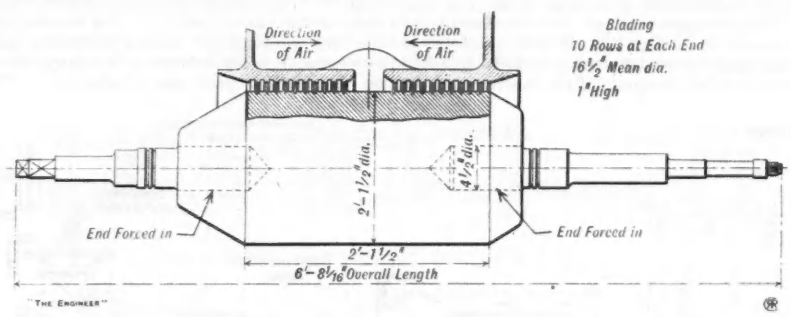


FIG. 29—ROTOR OF TURBO-BLOWER FOR FARNLEY

tightness it was turned with sharp-edged grooves, six to the inch, the ridges between the grooves running practically in contact with corresponding fixed ridges in the cylinder. The arrangement is illustrated to a larger scale in Fig. 26. The material used for the fixed ridges was a mixture of lead and antimony. The glands were of exactly similar design, following

against a back pressure of 1 lb. above that of the atmosphere. The turbo-blower was ordered to replace an old reciprocating blowing plant having a capacity of 9200 cubic feet of air per minute at 2·75 lb. pressure. The saving of space effected by the change was most striking. The reciprocating plant occupied a floor area 75ft. long by 12ft. wide.

forging, with stub shafts forced in at the ends. The bladed portion had a diameter of 15·5in. throughout. It carried two sets of blades, each consisting of ten rows of a uniform height of 1in. As in previous machines of the same nature, all blades were plano-convex in section, the fixed blades serving only to guide the air in a direction parallel to the axis of the rotor, and the running blades being set at an angle to act as the blades of an impeller.

The governor gear of the machine is interesting, as

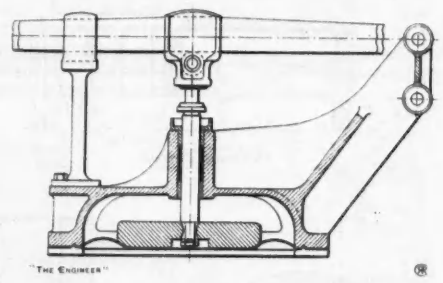


FIG. 31—GOVERNOR GEAR DIAPHRAGM

the speed was controlled by the pressure of the air at the outlet of the blower. On the top of the blower cylinder was a fitting containing a leather diaphragm, the underside of the latter being in direct contact with the air delivered. This diaphragm, the arrangement of which is shown in Fig. 31, was connected to a rocking

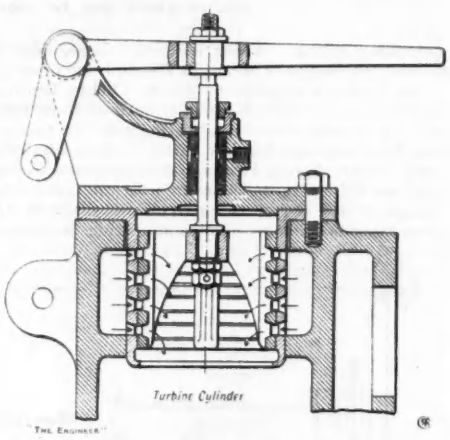


FIG. 32—GOVERNOR VALVE

shaft, this in turn being connected to a governor valve controlling the steam supply to the turbine. The governor valve was of the balanced multi-ported type, as illustrated in Fig. 32. An increase of air pressure under the diaphragm raised the latter and thus caused the valve to diminish the quantity of steam admitted, the contrary action taking place when the air pressure fell. A spring, the tension of

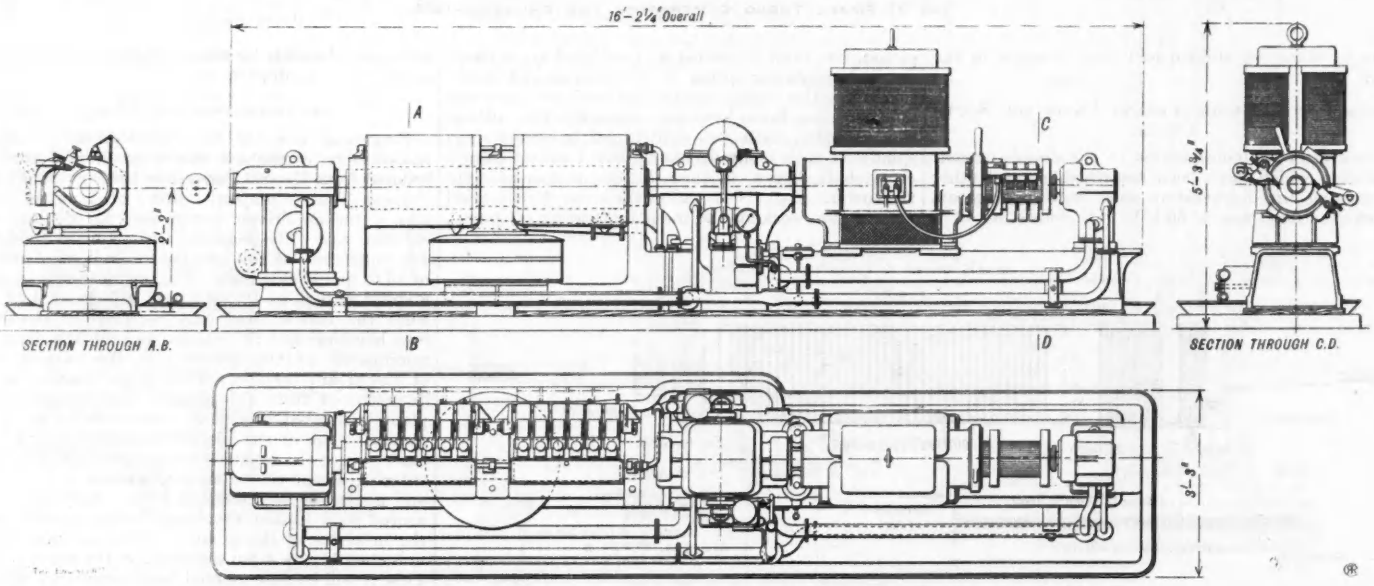


FIG. 30—UNI-POLAR MOTOR GENERATOR—1902

the practice adopted in the Manchester Square turbines of 1895.

The rotor of the compressor ran in bearings of the tubular type, consisting of three concentric tubes fitting loosely over the bush which encircled the shaft. This arrangement had been found very effective in preventing vibration of rotors running at very high speeds, and had been used for many years in turbine practice. A multi-collar thrust block, adjustable by means of a screw, served for the

The turbo-blower, in spite of its greater capacity, required a space only 15ft. 3in. long by barely 3ft. wide, or not much more than one-twentieth of that taken up by the reciprocating machine.

The blower was of the double-ended type, the air entering at each end and being discharged at the centre. A photograph of the complete machine is reproduced in Fig. 28, while the construction of the rotor and the arrangement of the blading will be understood from Fig. 29. The rotor was a solid steel

which could be adjusted by hand, also acted on the rocking shaft and provided for an independent regulation of the speed by the attendant.

With the object of getting exact data as to the performance of the plant, the Farnley Iron Company engaged Professor John Goodman, of the Yorkshire College, Leeds, to carry out a series of tests on its behalf. In his report, Professor Goodman stated: "In my tests I found that the blower actually delivered 11,356 cubic feet of free air per minute at a

pressure of 3·01 lb.; thus, in every respect the performance of the blower was better than the guarantee."

EARLY UNIPOLAR DYNAMOS.

The commutating type of D.C. generator has so completely dominated commercial practice that the possibility of producing direct current by a unipolar machine having no commutator at all is rarely called to mind. The first dynamo ever constructed, namely, the little machine exhibited by Faraday before the Royal Society in 1831, was, nevertheless, of this kind. It consisted of a plain copper disc rotating between the poles of a magnet, and supplied current from two brushes, one bearing on the circumference of the disc and the other on the shaft. The practical reasons against the development of the unipolar type of dynamo were, first, the very low voltage that it would give; and secondly, the necessarily high peripheral speed of the conducting disc or cylinder on which the brushes had to work. The lowness of the voltage was, however, no drawback when the current was wanted for many electrolytic purposes, while the great simplicity of the machines was a point in their favour.

The design of unipolar dynamos attracted the attention of Sir Charles Parsons at an early date, and in 1892 he constructed a machine on the unipolar principle for Elmores Patent Copper Depositing Company, of Leeds. It had an output of 6000 ampères at 1·25 volts, and was driven by a 16-kW motor at 1000 to 1500 r.p.m. Unfortunately, no drawings or photographs of this machine can be found. There is, however, an engraving in an old catalogue of Messrs. C. A. Parsons and Co., issued in 1897, which very probably represents the unit in question. The illustration is said to depict "One of our Continuous Current Transformers, consisting of Motor and Unipolar Dynamo coupled direct to each other and mounted on one bedplate." The following description accompanies the picture:—

"The Unipolar Dynamo consists of a soft iron shaft which passes through holes in the magnet poles. Over certain portions of its length it is covered with copper contact tubes upon which the brushes press. When the shaft rotates there is a difference of potential between the brushes. There is no commutator, and the surface of the copper being smooth, very large currents can be carried without sparking, undue heating or wear.

"It is designed for low voltages and large current, for metallurgical and electrolytic processes, including the electro deposition of copper, galvanizing, welding, etc."

From the engraving it is clear that the three vertical magnet limbs, through the upper ends of which the armature ran, were of rectangular section, cast solid with the bed-plate. The central limb only carried any exciting winding. The magnetic flux leaving this limb was divided, the two parts flowing in opposite directions axially along the armature. By duplicating the action of the machine in this way the voltage was doubled and the brushes were confined to the periphery of the armature. There were in all eight brushes, four positive ones on one side of the central pole and four negative ones on the other. A small reciprocating pump was belt driven from one end of the armature shaft, its function clearly being to deliver water into a line of spraying pipe extending over the length of the armature, and serving to cool it. The motor driving the machine was of the bi-polar overtype pattern, and was coupled directly to the end of the other end of the shaft.

No other unipolar dynamo seems to have been constructed by Sir Charles Parsons until 1902, when a 50-kW motor-driven unit was ordered by the Phœnix Process Trust, Ltd., of London. It was designed for an output of 10,000 ampères at 5 volts at 4000 r.p.m., and for 5000 ampères at 7 volts at 4700 r.p.m. The general appearance of this machine is shown in Fig. 32. Like its predecessor, the dynamo comprised an armature revolving inside three magnet poles, the bed-plate forming the yoke of the magnet. The central limb alone was wound with exciting coils. The armature was a cylinder of mild steel with copper sleeves encircling it between the poles. It was at first made hollow, as the intention was to cool it by the circulation of water through the interior, but owing to the magnetic density in the material being too high the central hole was afterwards filled up by a steel spindle which was driven in. Another method of cooling had therefore to be provided, and this took the form of a series of water sprays playing on the copper collector sleeves just in front of the brushes. The spent water fell into a trough of sheet copper encircling the lower half of the armature, whence it was withdrawn by a pump and re-circulated. A hinged flap was fitted over the spraying pipes to direct the water on to the armature. Further details of the brush gear and sprinkling pipes are given in Fig. 33. The pump delivering water to the spray pipes was driven from one end of a slow-speed cross shaft in the pedestal between the dynamo and the motor. From the other end of the cross shaft was driven the lubricating pump which supplied oil under pressure to a forced lubrication system serving all the bearings of the unit. The motor driving the unipolar dynamo was of the usual design for the period, with overhead horseshoe field magnets. It was separately excited at 180 volts.

(To be continued.)

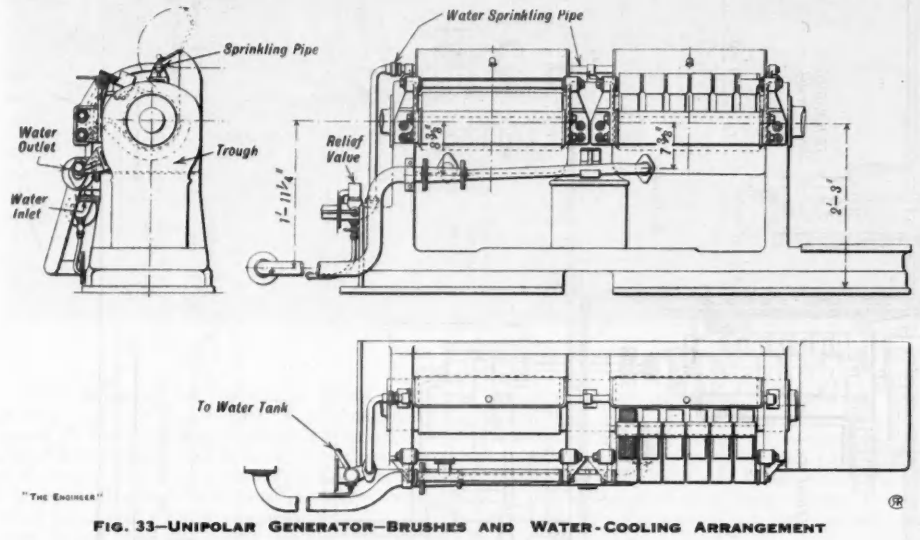


FIG. 33—UNIPOLAR GENERATOR—BRUSHES AND WATER-COOLING ARRANGEMENT

The Iraq Pipe Line.

No. II.

(Continued from page 76, January 18th.)

IN our first article we gave a short historical survey of the development of the Iraq oilfield, together with some details of the design of the pipe lines from Kirkuk to Haifa and Tripoli, and a short account of their construction. To-day we propose to deal principally with the main and auxiliary pumping plants and the general station and pipe line equipment.

THE PUMPING STATIONS.

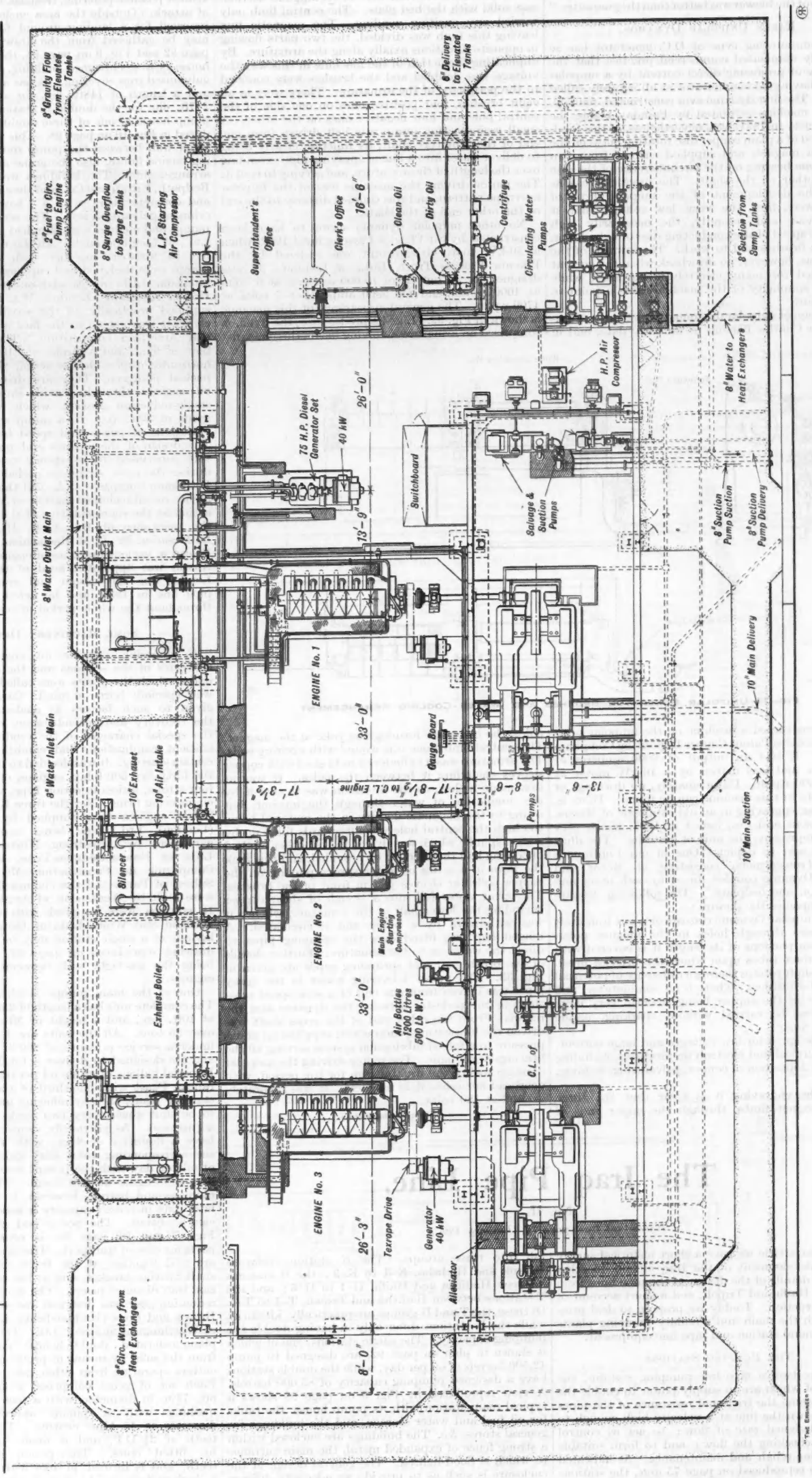
There are twelve pipe line pumping stations, the functions of which are to supply power to enable the oil to overcome the frictional resistance of the pipes and pass down the line at a velocity high enough to give the designed rate of flow; to act as control points for checking the flow; and to form suitable bases for line repair and maintenance. As indicated in the map reproduced on page 75 *ante*, the stations fall into three groups. The K stations between Kirkuk and Haditha, K–1 to K–3; the H stations between Haditha and Haifa, H–1 to H–5; and the T stations between Haditha and Tripoli, T–1 to T–4. Of these, the T and H groups are practically identical, while the K stations differ only in having double the pumping capacity. The single stations, one of which is shown in plan on page 92, are designed to pump 42,500 barrels of oil per day, while the double stations have a designed pumping capacity of 85,000 barrels. A view reproduced in Fig. 9 on page 98 shows a typical main station with its pump house, the tanks for oil fuel and water storage, and the buildings for general stores, &c. The buildings are enclosed within a strong fence of expanded metal, the main entrance to which is flood-lighted. The general design of the enclosure is such as to provide an adequate defence against possible pilfering, trespass, or the milder forms of attack. Outside the area enclosed there is space reserved for a landing ground for aeroplanes. As may be gathered from the drawing reproduced on page 92 and Fig. 9 on page 98, the pump and engine house is a steel-framed building, with a corrugated galvanised iron covering. It has a width of 56ft. 6in. and a length of 148ft. 6in. for single stations, and 247ft. 6in. for the double K stations. A view of the pump house of one of these double stations is reproduced in Fig. 10 on page 98. This view shows the fireproof wall between the pump room and the adjoining engine house, also the crane gantry and lighting arrangements. The buildings were all supplied by Redpath, Brown and Co., and they have steel windows and concrete floors, with a "bowstring" ceiling of crimped galvanised iron. The service cranes for the pumps and engines were supplied by Herbert Morris, Ltd., of Loughborough. All the main pumps, forty-five in number, together with a complete spare pump, were designed and supplied by Worthington-Simpson, Ltd., of Newark-on-Trent, and Queen's House, Kingsway, London, W.C.2, which firm also supplied practically all the auxiliary pumps. The contract was gained in the face of keen Continental and American competition. The pumps have a bore of 6¾in. and a stroke of 24in., and are of the horizontal duplex double-acting type, with outside-packed plungers. They are driven by 500 b.h.p. oil engines through David Brown double-helical single-reduction gearing, which lowers the engine speed of 300 r.p.m. to a pump speed of 44 r.p.m., variations of power and speed being provided for. The design of the engines and pumping machinery was supervised by a special technical staff, and during the most strenuous period of work the Iraq Petroleum Company, Ltd., had the advantage of the advice on all technical matters of Mr. J. A. Jameson, acting as the representative of the chairman, and of the assistance of Mr. A. C. Hartley, Mr. L. J. Le Mesurier, Mr. D. M. Maclachlan, and Mr. R. Allan Brown in various branches of engineering; Mr. H. S. Austin was appointed head of the department in London for the design and construction of the pipe line in 1930, and he acted in that capacity throughout the whole period of construction.

SOME MACHINERY DETAILS.

In choosing suitable oil engines, the remote character of the stations and the special conditions under which the plants were called upon to operate, were specially borne in mind. Careful attention was given to such factors as enclosure against dust, the recovery and reconditioning of lubricating oil, the special character of the crude fuel oil, and its efficient combustion, and conditions for easy and certain starting. It was decided to place the orders for the forty-five 500 b.h.p. engines, of the five-cylinder, four-stroke, airless-injection type, with three leading engineering firms. For the three K stations eighteen Sulzer engines were supplied by Sulzer Brothers (London), Ltd., nine being manufactured under agreement by Armstrong Whitworth (Engineers), Ltd., at Newcastle-upon-Tyne, and nine by the Compagnie de Construction Mécanique Procédés Sulzer, of Paris. All the engines for the T stations were built by Werkspoor, of Amsterdam, while the H stations were supplied with engines built by Harland and Wolff, Ltd., of Belfast. The general lay-out of a single station may be studied from the drawing reproduced on page 92, a special feature being the gas-tight wall between the pumps and engines.

One of the main pumps is illustrated in Fig. 7. The complete unit has a length of 25ft., with a breadth of 10ft. 3in., and a height of 5ft., and weighs just over 25 tons. All the units are designed to operate under a service pressure of 800 lb. per square inch, and are designed to deliver a total of over 3 million Imperial gallons of crude oil per day to the Mediterranean Coast with one-third of the units acting as standby plant, thereby allowing one engine in three to be shut down every two weeks for cleaning and adjustment. As previously mentioned, the plungers have a diameter of 6¾in., with a stroke of 24in., the corresponding total duty being 21,000 barrels of oil per day with the pumps running at 44 r.p.m., and the engine at 300 r.p.m. The design of the plungers and barrels, however, is such that if at a later date increased capacity is needed, 7in. plungers can be fitted. The power end of the pump—see Figs. 7 and 10, page 98—is constructed in three parts for ease of transport. The two main side frames are tied together at the front end by the pinion shaft bearing bracket, and at the rear end by heavy cast iron distance pieces. The double-helical, single-reduction gear was designed and supplied by David Brown and Sons (Huddersfield), Ltd., to the order of Worthington Simpson, Ltd. The teeth are of the plano-generated double-helical pattern generated from the solid by means of profile-ground, rack-type cutters operating from either side of the gear wheel. Each set of gears comprises a large steel wheel, 6ft. 7¾in. in diameter, with a face width of 15½in., meshing with a pinion approximately 12½in. diameter at 45·41in. centres. The wheel has 198 teeth of 2½ D P, and is made in halves secured by fitted bolts. The pinion has twenty-nine teeth, and is formed in one with the shaft from a high-carbon solid steel forging. In order to

SINGLE-TYPE PUMPING STATION ON THE IRAQ PIPE LINE



prevent oil leakage grooves are formed on the shafts on either side of the wheel and pinion. The design adopted is such that the gears, we are informed, operate efficiently and quietly under day and night service and constantly varying loads, which may fluctuate between 270 and 470 b.h.p.

Continuing our description of the main pump, reference may be made to the closed crank chambers and the lubricating oil collecting sumps. The main bearings are lined with copper-antimony, hardened tin babbitt metal, and they are adjustable. The fluid ends of the pumps were made from specially selected forged steel ingots, machined all over, with the plunger chambers and suction valve boxes trepanned out, and with all the passages, ports, and recesses drilled from the solid. Before fitting the valve seats, which are of forged stainless steel, both the suction and delivery chambers were subjected to a test pressure of 1200 lb. per square inch with kerosene over a continuous period of twenty-four hours, any change of pressure being noted by a recording meter. Similar tests were applied to the suction and delivery manifolds, which are made from solid-drawn steel tubes. The pump is furnished with by-pass relief valves from suction to delivery, which are used when starting, while, in order to absorb any shocks which may come on the line, and to smooth out further the flow so as to give quiet and gentle operation of the valves, a special type of mechanical alleviator has been fitted to each pump.

A section through one of these alleviators is reproduced in Fig. 8. It was designed by Wheatley Brothers, of Tulsa, Oklahoma, U.S.A., and was constructed under agreement by Worthington Simpson, Ltd.

The normal pattern of air vessel is not completely satisfactory when working with oil at high pressures, owing to the absorption of air, which necessitates frequent replenishment of the air supply. In the alleviator shown in Fig. 8, although a portion of the oil column is in contact with the air, the air and oil column in the top part of the cylinder is separated from the main oil system by a piston carrying six rings within which is a spring-loaded by-pass relief valve, a shut-off valve which automatically seats itself on failure of line pressure when the piston reaches the bottom of the cylinder and a small cut-in valve which admits oil through the piston and raises it when pressure is re-established. The air chamber is provided with a Klinger reflex gauge, and an air-charging and relief valve. By charging the chamber with 1000 lb. pressure air, the requisite level can be regulated for maximum cushioning effect, and when once established the level is, we understand, maintained over very long periods without a further charge. There is a by-pass connection between the upper and lower ends of the chamber and a feeler rod is provided to test the position of the piston. The device is one which should prove very useful for high-pressure lines, whether for oil, water, or other liquids.

Another important feature of the main pumps is the enclosure of all the moving parts in gas-tight casings in order to prevent the contamination of oil by dust from sandstorms, &c. The reciprocating motion of the pumps is utilised to draw fresh air through Vokes Protectomotor type air filters into the casings, Worthington patented feather valves being used as intake and non-return valves. The filter inlets are fitted, as shown in Fig. 7, both at the back and the front ends on either side of the pump, the discharge being led outside the building into the sump. The lubricating system was specially designed, keeping in mind the high temperature which is experienced during certain parts of the year. As will be seen from the pump illustrated on page 98, there is a sixteen-feed Wakefield type visible forced-feed lubricator mounted at the front end of each pump with solid drawn connections to all moving parts and bearings. The oil is drained to an underground tank, where it is filtered and recirculated.

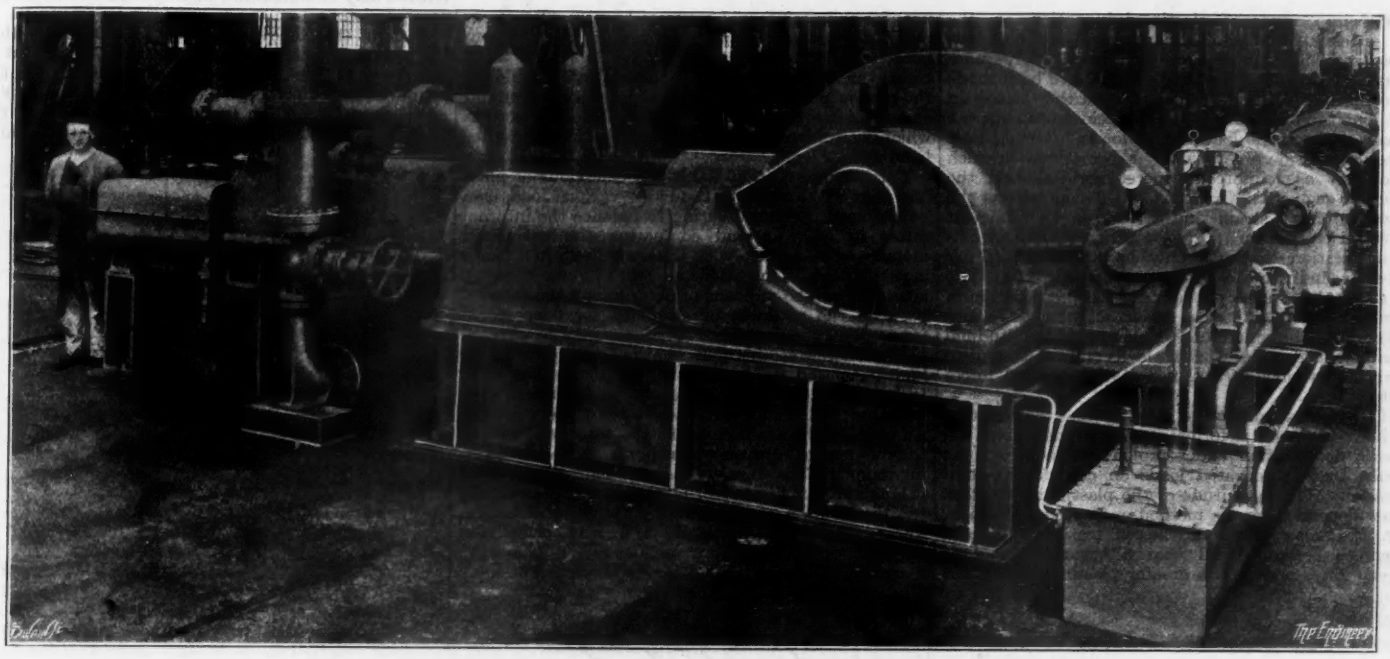


FIG. 7—IRAQ PIPE LINE—MAIN OIL PUMP IN MAKERS' WORKS

At the back of the lubricator box there are four suction pumps, each with a capacity of 1½ pints per minute. These are coupled to each pinion shaft bearing and other parts of the main pump, the surplus oil being delivered to the underground tank, which is equipped with grille cooling, the oil being taken from the suction side of the main oil pump and passed through the cooling coils by a Worthington "Nuflo" rotary pump before being discharged into the lubricating system.

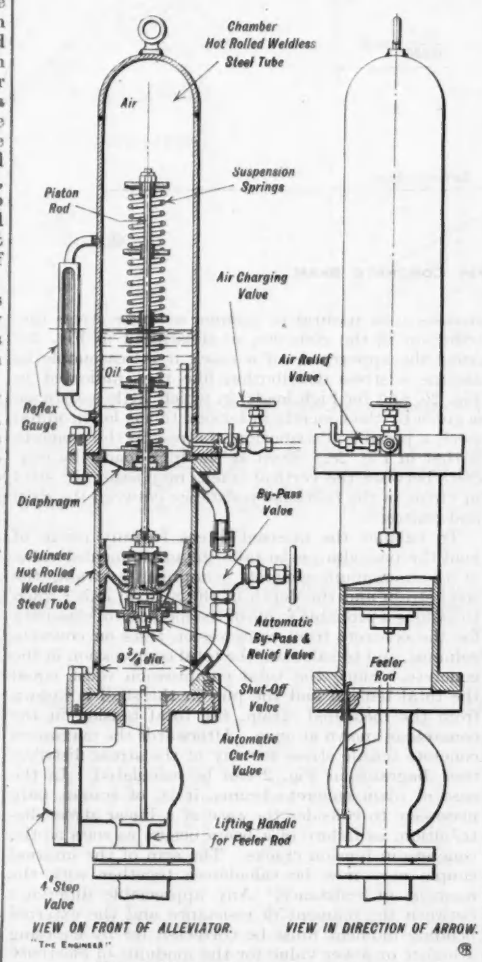


FIG. 8—MECHANICAL ALLEVIATOR

The drawing reproduced on page 92 also shows the auxiliary pumps and the power and lighting generators. The main shaft between the engine and the pump operates a 45-kW B.T.H. generator by means of a texrope drive, and these generating sets are attached to all units in the small stations and to the first four units in the large stations. As a standby a similar generator coupled direct to a 75 b.h.p., three-cylinder National oil engine is provided. Fig. 12 on page 98 shows one of these auxiliary generating sets.

The auxiliary plant also includes three separate air supply systems in each station. For starting the National oil engine there is a Lister petrol engine driving a Reavell air compressor, which delivers air at 300 lb. per square inch. This air is utilised for starting and also for cleansing the Vokes Protectomotor pattern air filters. For starting the main engines Laurence Scott motor-driven air compressors, operating at a pressure of 570 lb. per square inch, is employed, the air compressors being of the Harland and Wolff type in the H stations and of the Reavell type in the K and T stations. The third air system has an operating pressure of 1000 lb. per square inch, and is used for charging the alleviators on the main pumps. The compressors are of the Reavell pattern and are driven by Laurence Scott motors. The auxiliary equipment further includes three Worthington circulating pumps, both engine and motor driven. For the engine circuits a completely closed system is employed, the heated jacket water being cooled by passing through a heat exchanger, which is placed before the silencer in the exhaust pipe line, and in the suction connection to the individual main line pumps. In this way the main oil stream is used as a coolant, and at the same time the oil temperature being raised, the incoming oil is easier to pump. The circulating water pumps are both motor and engine driven, and are of the Worthington pattern, with outputs of 250 gallons for the small stations and 450 gallons for the large stations, delivered against a head of 69ft., the water temperature being about 180 deg. Fah.

For fire service, heating water supply, and other uses, Worthington pumps are also used. Two interesting pumps within the pump house are the suction and salvage pumps, which are electrically driven through shafts extending through the fire wall. They are designed to deal with crude oil and water, and are available for draining the pipe line or tanks in case of fracture at any point. The larger pump has a designed output of 20,000 gallons and the smaller 4000 Imperial gallons per hour with working pressures of 125 lb. and 250 lb. respectively. Each pump has very close clearances for dealing with high suction lifts at altitudes up to 2500ft. above sea level and at temperatures varying from 20 deg. to 130 deg. Fah., when pumping either oil or water. For reconditioning the lubricating oil a Hopkinson centrifugal purifier and washer, electrically driven, is used, and is designed to deal with 140 gallons per hour. The total capacity of the lubricating oil storage tanks is 2300 gallons, and they are arranged above the ground, so that when draining off the crank case oil fresh oil can be conveniently run in by gravity, without having to shut down the engines or the pumps.

The fuel supply for the main engine is taken from the discharge pipe line and is stored in two elevated cone-bottomed fuel tanks—see Fig. 9 on page 98. Each of these tanks has a capacity of 6135 gallons, and feeds the supply system under gravity. The stations carry a very complete fire-fighting equipment, and in addition to the fireproof walls there are numerous hydrants, also foam-generating equipment for producing fire-fighting fluid.

(To be continued.)

Strain and Stress Distribution in Concrete Beams.

By R. H. EVANS, M.Sc., Ph.D., A.M.I. Mech. E.

THE importance of plastic deformation on the stress distribution of plain and reinforced concrete sections is now receiving considerably more consideration. Many investigations have been made in connection with the deflection and the stresses in the longitudinal reinforcement of reinforced concrete beams under static loads. Live loads, however, may produce considerable plastic deformations in such structures as reinforced concrete bridges and the effect of such plastic yielding of the concrete on the distribution of strain and stress, on the moment distribution and on the position of the neutral axis is a question that can only be finally solved by extensive individual experimentations. It is desirable to study the tendency, if any, of self-preservation in reinforced concrete, the extent of the assistance afforded by the concrete in tension to the longitudinal reinforcement under working loads and to attempt to derive a satisfactory balance of the internal forces in beams.

The simplest method of investigating the question of how the plastic deformation may deviate from the elastic deformation under prolonged loadings is no doubt that of repeated loads on columns in compression. The magnitude of the plastic deformation must depend upon the method and speed of loading. Dr. E. Probst, for example, in testing reinforced concrete beams, found that a sustained load of twelve days produced a greater plastic strain in the compressive section of the concrete than 1,100,000 repetitions, and that irregularity in the speed of application of live loads may stress the material to a higher degree than a regularly repeated loading.

The writer has carried out a number of prolonged tests on plain and reinforced concrete beams with observations of the distribution of strain along the depth of each beam for repeated and sustained loads, the tests on some beams often occupying three to four weeks. Tests, so far, have been made mainly on beams having spans of 30in., 50in., and 60in., and of rectangular and T section. In this paper it is proposed to discuss the general results of the investigation by referring to a few of the diagrams obtained from one plain and one reinforced concrete beam, the latter having no compression reinforcement. The strain measurements were made by means of a specially designed portable 8in. extensometer along the depth of all the beams. The beams were loaded at the middle third points and readings were taken in the middle third portion, this being very convenient from the point of view of constant bending moment and zero shearing force. Readings were taken at zero load and at a number of increasing and decreasing loads in each cycle of loading. The total strain at any period of the testing can be thus plotted, after having first corrected for shrinkage and temperature changes from the control beam, in order to determine the effect of the permanent set in the strains on the distribution of strain and on the position of the neutral axis.

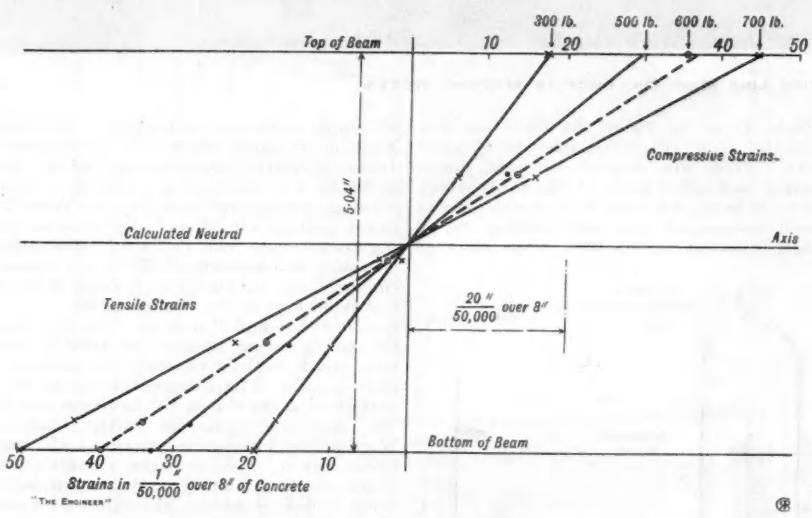


FIG. 1—STRAINS IN PLAIN CONCRETE BEAM

PLAIN CONCRETE BEAMS.

The plain concrete beams were of rectangular section and the strains obtained for one particular beam have been plotted in Fig. 1. The observations do not include the permanent set, but only the strain differences between zero load and the given load, the readings being taken as soon as the load had been applied. It is clear from the graphs obtained that the strain distribution is linear up to the breaking load, and that the neutral axis in a plain beam does not rise as in reinforced concrete beams. The maximum stresses in a plain beam are, of course, comparatively low, and the only possible reason for a change in the position of the neutral axis would be the plastic properties of the concrete in tension and compression. Hence in plain concrete beams sections which were plane before bending remain plane after bending.

Further information about the behaviour of plain and reinforced concrete beams at various loads can be obtained by endeavouring to balance the internal forces in a beam and comparing the calculated moment of resistance with the actual external bending moment. In addition, with plain concrete beams, it will be a means of determining the relation between the modulus of elasticity for concrete in tension and compression. A balance may be effected as the concrete strains along the depth of the beam are known as well as the position of the neutral axis. It is only necessary then to choose a value of the modulus of elasticity for concrete such that the total compression becomes equal to the total tension and the moment of resistance sensibly equal to the bending moment. From many tests on concrete columns, it is found that little error is introduced by assuming the distribution of stress above the neutral axis is linear. The chief difficulty arises in connection with the stress distribution in the concrete below the neutral axis of reinforced concrete beams. For small stresses it is natural to assume a linear stress distribution in the concrete, as illustrated in Fig. 2*a*. After the appearance of a crack it is reasonable to assume a stress distribution like that indicated in Fig. 2*b*, and for high loads, in which little assistance is given by the concrete in tension to the longitudinal steel, a possible distribution of stress in the concrete is that in Fig. 2*c*. Even at the high loads the concrete between the vertical cracks may assist the steel in virtue of the frictional resistance between the steel and concrete.

To balance the internal forces for any range of load the procedure is to take the experimental value of the maximum concrete compressive strain, the steel strain and the depth of the neutral axis; then to assume a probable value of the modulus of elasticity for the concrete from compression tests on concrete columns, and to calculate the total compression in the concrete. Since the total compression must equal the total tension and the pull in the steel is known from the measured strain, the total tension in the concrete is known at once. Afterwards the maximum concrete tensile stress for any of the stress distribution diagrams in Fig. 2 can be calculated. In the case of plain concrete beams, it is, of course, only necessary to consider the case of a linear stress distribution, as failure of a beam occurs as soon as the concrete in tension cracks. The arm of the internal couple may now be calculated, together with the moment of resistance. Any appreciable difference between the moment of resistance and the external bending moment must be corrected for by choosing a higher or lower value for the modulus of elasticity of concrete. A series of loads for a given beam may be satisfactorily and conveniently balanced after a close balance for the first range of load has been effected.

In order to derive a satisfactory balance of the internal forces in the plain beams it was generally necessary to assume a lower value of the modulus of elasticity for concrete in tension than in compression. The modulus assumed in tension for this particular beam with a load of 700 lb. was $3{\cdot}16\times10^6$ lb. per square inch and in compression $3{\cdot}5\times10^6$ lb. per square inch. Thus the required modulus in tension had a value equal to 0·9 of that in compression. This result agrees with the tests carried out by the author on concrete columns in both tension and compression. The same conclusion was deduced by A. N. Johnson[1] and J. W. Johnson[2], though Professor Mörsch's[3] tests, on the other hand, indicate that the modulus in tension may be sometimes slightly higher than that in compression.

Tests at the Building Research Station[4] show that the creep of concrete in tension is the same as that in compression. That this is so is also indicated by the results obtained from the plain concrete beams. The concrete strain on the top and bottom faces of the beam was measured by mirror extensometers, which enabled the strain over a gauge length of 8in. to be measured to 1×10^{-6} of an inch. The plastic strain could be thus deduced at any time, after having made the necessary correction for shrinkage and temperature from the control beam. For example, for a maximum load of 700 lb. on this beam the results were :—

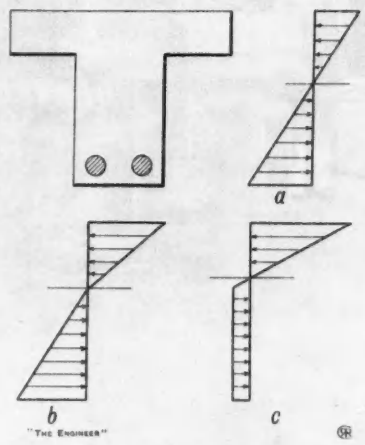


FIG. 2—STRESS DISTRIBUTION DIAGRAMS

Range of load.	Maximum immediate strains over 8in. of concrete.		Per cent. set in compressive strain.	Per cent. set in tensile strain.
	Tension.	Compression.		
0–700	0·00119	0·00104	29·3	29·2

The maximum permanent set in compression due to the plastic nature of the concrete is thus sensibly equal to that in tension, the maximum stresses being practically the same. The maximum concrete tensile strain is somewhat greater than the maximum concrete compression strain, so that, with a linear strain distribution as in Fig. 2, a lower value of the modulus will have to be assumed in tension than in compression.

REINFORCED CONCRETE T-BEAMS.

A selection of the strain distribution curves for a reinforced concrete beam have been plotted in Figs. 3–6, the order in which they were recorded being numbered from unity. The missing numbers are thus in the diagrams that the writer has omitted for the sake of brevity.

For small loads it is obvious from Figs. 3 and 4 that the strain distribution is linear and that the actual position of the neutral axis agrees with that calculated assuming a modular ratio of 8 for this 3 : 1 concrete mix. In addition, examination of such lines as 7 and 9 shows that there is a considerable lag in the strains when the loads are being reduced. This, of course, is to be expected, as it is well known that concrete exhibits plastic properties in both tension and compression, such that the stress-strain diagram forms a hysteresis loop. If the strain readings for any particular depth were plotted for some cycle of loading a hysteresis loop would be obtained with probably some permanent set. Line 10 in Fig. 3 also shows the total strain for 1500 lb., some of this strain including the permanent set due to the previous continued and repeated loadings. Since the strain is still linear, it follows that the creep is proportional to the stress, this agreeing with experimental work at the Building Research Station and with the results obtained on plain concrete beams.

The concrete in tension thus affords definite assistance to the longitudinal steel reinforcement at low loads, and it will diminish when the maximum concrete tensile stress is at least equal to or greater than the tensile strength of the concrete. From Fig. 4 it is clear that a vertical crack has appeared by the time a load of 1750 lb. has been applied. While the strain distribution above the neutral axis is again practically linear, that below the neutral axis is no longer such. The steel now restrains the concrete in tension

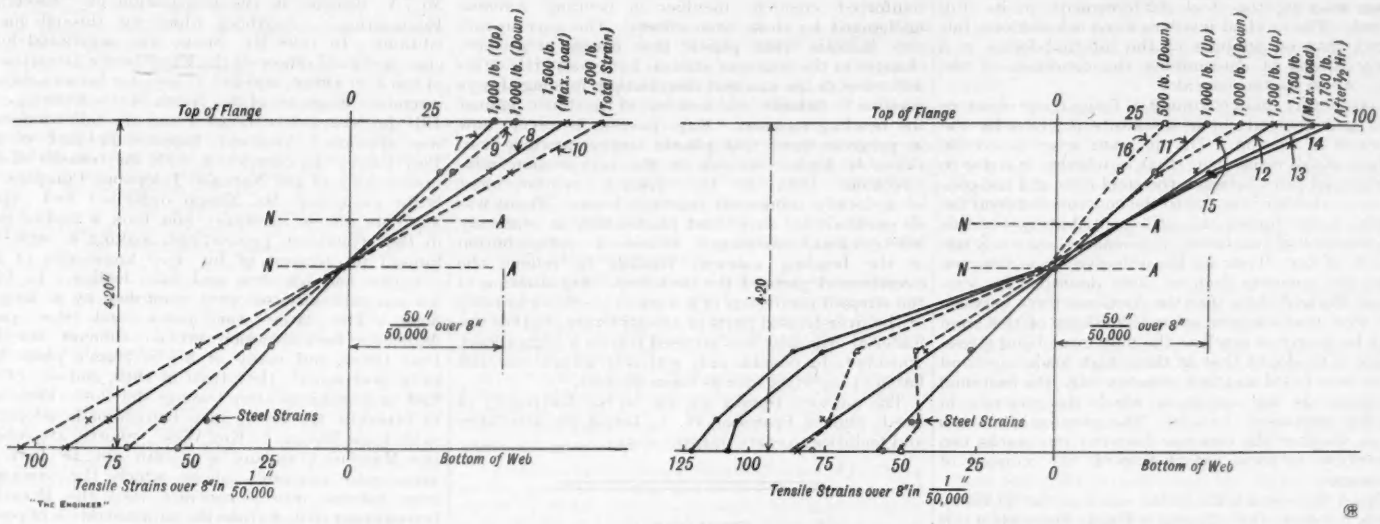
[1] A. N. Johnson. Public Roads. Washington, 1929.
[2] J. W. Johnson. Engineering Expt. Station, Iowa.
[3] Max Forster. Taschenbuck für Bauingenieure, 1920.
[4] Building Research Station Report 1930.

from complete fracture and the diagram below the neutral axis is convex to the neutral axis. In addition, the axis is now somewhat higher.

The effect of the creep of the concrete and of the condition of the concrete below the neutral axis is illustrated by lines 13 and 14 in Fig. 4. On reducing the loads the steel will tend to restore the concrete to its initial state of strain, but the concrete in tension, being now cracked, will have been overstressed and will cause the strain diagram below the axis to become more and more convex to the axis. Lines 15 and 16 in Fig. 4 and lines 23 and 24 in Fig. 5 clearly illustrate this point. Line 24 shows the distribution of the permanent set along the depth of the beam after a maximum load of 2500 lb., and it is observed that the neutral axis continues to rise as zero load is approached. This phenomenon is a result of the residual tension in the steel.

Considering Figs. 5 and 6, we see that the strain curve above the neutral axis is still only slightly concave to the axis and that below the neutral axis the strain is convex to the neutral axis. On comparing these results with those of A. T. Goldbeck[5] we note that Goldbeck concluded from his tests on rectangular beams of 1 : 2 : 4 mix that for all practical purposes the curves of unit deformation are straight lines with a tendency to become concave upward above the neutral axis and concave downward below the neutral axis as the loading progresses. In most of the beams the total compression greatly exceeds the total tension in the steel, and the depth of the neutral axis was greater than that calculated excluding the tension in the concrete. Tests by Dr. R. Müller on reinforced concrete beams show that for small loads the strain distribution is sensibly linear and that for high loads the distribution above the neutral axis has a tendency to become concave downward, whereas below the neutral axis the strain is relatively greater than that above the neutral axis, but is such as to give practically a straight line. At the high loads, from Fig. 6 the actual position of the neutral axis agrees nearly with that calculated excluding the tension in the concrete, *i.e.*, with the calculations made in accordance with the straight-line no-tension theory. Further, as the load is being increased we see that the neutral axis first rises and afterwards falls somewhat, this fall being presumably due to the plastic properties of the concrete on the compression side. It is clear, too, from line 60 in Fig. 6 that the position of the neutral axis including the permanent set is still below that estimated excluding tension.

Many investigators have determined the position of the neutral axis by measuring the steel strain and the concrete compressive strain at the top of the beam and assuming the strain distribution between these points is linear. Thus the point where the line joining these points intersects the vertical line gives the estimated position of the neutral axis. The accuracy of this method may be investigated by the results obtained on a large number of beams tested by the author. Thus for this particular T-beam the method is very satisfactory up to half the failing load and for higher loads it gives slightly too low a position for the axis. In general, the agreement is satisfactory even at the higher loads, the actual position being sometimes above and sometimes below that obtained with this method.



FIGS. 3 AND 4—STRAINS IN REINFORCED CONCRETE BEAMS AT LOW LOADS

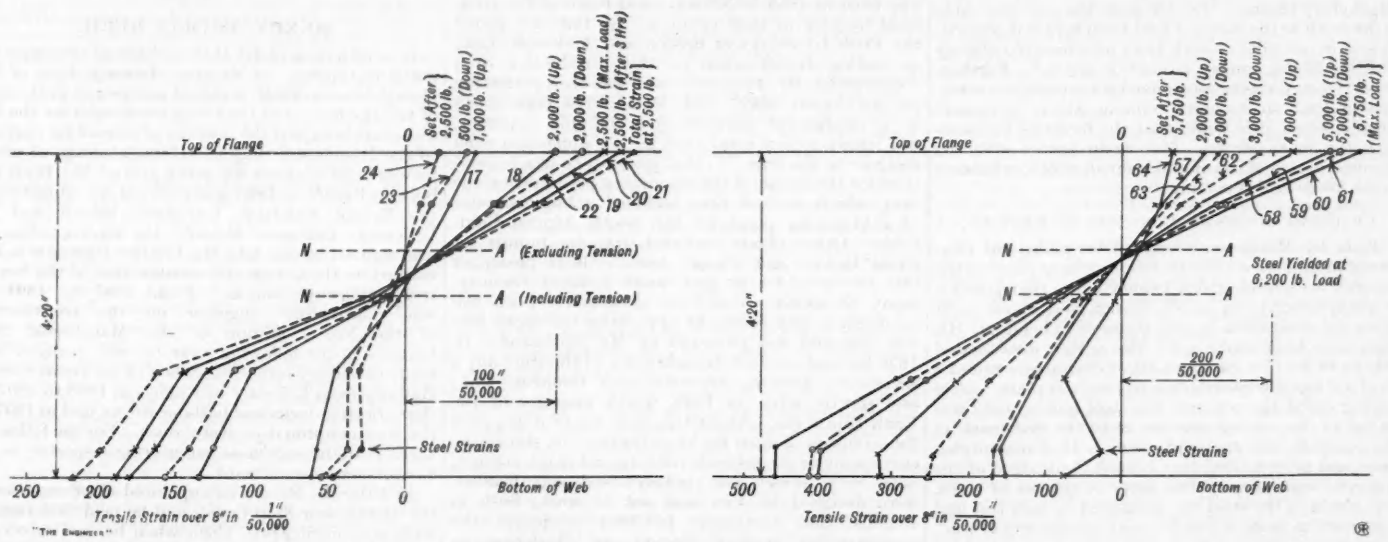
Many investigators have determined the position of the neutral axis by measuring the steel strain and the concrete compressive strain at the top of the beam and assuming the strain distribution between these points is linear. Thus the point where the line joining these points intersects the vertical line gives the estimated position of the neutral axis. The accuracy of this method may be investigated by the results obtained on a large number of beams tested by the author. Thus for this particular T-beam the method is very satisfactory up to half the failing load and for higher loads it gives slightly too low a position for the axis. In general, the agreement is satisfactory even at the higher loads, the actual position being sometimes above and sometimes below that obtained with this method.

BALANCING OF INTERNAL FORCES.

As already stated, the difficulty arises in connection with the stress distribution in the concrete below the neutral axis. For small stresses it is correct to assume such a distribution of stress as in Fig. 2*a*. Strains have been measured over 8in. so that when a crack appears within the gauge points of the extensometer the stress deduced from the observed strain is a kind of mean stress. For example, the steel stress at the crack must be nearly equal to that calculated excluding tension. Hence after the appearance of a crack a possible mean distribution of stress is that in Fig. 2*b* and for very high loads this may become somewhat as illustrated in Fig. 2*c*.

To convert the concrete strains into stress it is necessary to assume a modulus of elasticity for the concrete. The modulus varies, not only with the magnitude of the mean stress, but also with the range of the variation of stress in addition to the time interval. Clearly then the value of the modulus to be assumed will depend upon the range of load applied to the beam and may be estimated from tests on concrete columns in compression.

Table I, for example, shows the data deduced in balancing the internal forces of this T-beam. Columns 9 and 10 in the table are of particular interest in regard to the load at which a crack must have appeared and in showing the general behaviour of the concrete in tension at the higher loads. Thus considerably less assistance is given by the concrete in tension at a load of 1000 lb., although strain distribution line No. 11 in Fig. 4 is almost a straight line. Line 13, however, at 1750 lb. load does indicate that the concrete must have cracked. Actually the first hair line crack was not seen until a load of 1750 lb. had been applied in spite of the fact that the beam faces were covered with a thin coating of plaster of paris. A method that has been suggested for the observance of cracks is to immerse the beam in water for some time prior to testing. It is stated that dark lines will



FIGS. 5 AND 6—STRAINS IN REINFORCED CONCRETE BEAMS AT HIGH LOADS

TABLE I.

Range of load.	Actual depth of N.A., in.	E. in 1×10^6 units.	Max. concrete comp. stress.	Total compression, lb.	Actual pull in steel, lb.	Total tension in concrete.	Diagram of stress distribution	Max. concrete tensile stress to balance.	Max. concrete tensile stress for linear distribution.	Arm, in.	Bending moment lb.-in.
0– 500	1·87	3·0	180	846	365	481	3A	215	220	3·04	2,500
0–1000	1·80	3·0	361	1,644	780	864	3A	372	480	3·06	5,000
0–1500	1·80	3·0	526	2,391	1,280	1,111	3B	478	702	3·10	7,500
0–1750	1·77	3·0	608	2,740	1,746	994	3B	421	835	3·10	8,750
0–1750	1·77	3·0	608	2,740	1,746	994	3C	236	835	3·12	8,750
0–2500	1·70	2·9	913	3,988	2,730	1,258	3C	280	—	3·07	12,500
0–4000	1·44	2·8	1,600	6,221	5,300	921	3C	144	—	3·19	20,000
0–6000	1·40	2·8	2,420	9,158	7,900	1,258	3C	229	—	3·25	30,000
0–1000	1·40	3·0	435	1,651	1,013	638	3C	120	—	3·03	5,000
0–2000	1·37	3·0	820	3,111	2,720	391	3C	70	—	3·27	10,000
2000–3000	1·37	3·4	425	1,574	1,230	344	3C	62	—	3·19	5,000
4000–5000	1·37	3·6	414	1,535	1,230	305	3C	54	—	3·20	5,000

[5] A. T. Goldbeck. "Proc.," Amer. Soc. Test. Mat., 1910.

then appear during testing at the sections which are about to crack. With prolonged tests the method is, naturally, unsuitable and a discussion of some special tests relating to the cracking stress of concrete will be made towards the end of this paper.

This method of balancing the internal forces, however, does appear to be very reliable in indicating the exact load at which the concrete in tension begins to cease assisting the steel reinforcement to its full extent. The method involves some calculations, but shows that an analysis of the internal forces is a ready means of determining the condition of the concrete on the tension side.

Considering again column 9 in Table I, one observes that at high loads little assistance is given by the concrete in tension. The question arises as to the nature of this resistance; that is, whether it is due to a frictional force between the steel rods and the concrete or whether it is due to the concrete between the cracks being intact and still contributing towards the moment of resistance, as calculated over a gauge length of 8in. Tests on the adhesive stress between steel and concrete such as those described by Professor Mörsch[6] show that the frictional force between the steel and concrete after the failure of the bond may be nearly as much as the maximum bond stress. There is no doubt that at these high loads the bond must have failed and that, consequently, the frictional resistance is one means in which the concrete in tension may assist the steel. The question also arises as to whether the concrete between the cracks can contribute to some extent towards the moment of resistance.

Since there is a limit to the value of the frictional force, it follows that slipping will take place when this value is exceeded and that slip may occur several times during a large change of load. This means that once the bond has failed the assistance given by the concrete to the steel will be roughly constant, but will be somewhat irregular on account of the periodic slipping. This appears to be borne out by the concrete tensile stress figures in the lower half of column 9 in Table I.

Another point of interest is the value of the modulus of elasticity necessary in column 3 to effect a satisfactory balance. In each table the modulus tends to diminish as the range of load from zero is increased. This is in accordance with tests on concrete columns with increasing ranges of load or stress.[7]. Further, when the modulus is determined for a constant variation of load on concrete columns about increasing mean stresses, it is found that the modulus increases with the mean stress. This again agrees with the required values of the modulus for an effective balance in the lower half of column 3.

CRACKING STRESS OF CONCRETE IN BENDING.

Tests by Monsieur Considere[8] on plain and reinforced prisms show that the reinforcement enabled the concrete to stretch about twenty times that possible in plain concrete in direct tension and about eight times the elongation of plain concrete in bending. His tests were later confirmed. The author investigated this point by first casting a layer of concrete round a steel rod and afterwards on a rectangular plate. After having cured the concrete the steel rod or plate was pulled in the testing machine until the first crack in the concrete was observed, using a 10–1 magnifying glass and after having first coated the surface of the concrete with a very fine layer of plaster of paris. The strain in the steel was measured in each test and observations were taken for small increments of load. Experiments showed that with a ¼in. rod embedded in concrete the results were irregular, possibly on account of some initial curvature of the rod and uneven gripping of the rod in the jaws of the testing machine.

The results obtained show that when the cover of concrete is only about ¼in. the actual cracking load appears to be consistently high by as much as four to six times. When, however, the cover of concrete was increased to 1in. the cracking load always agreed very satisfactorily with that calculated from the tensile strength and the modulus of elasticity of the concrete. It does seem then that with a thin cover of concrete either the hair line crack is so fine that it cannot be immediately seen or the steel enables it to stretch more. When the cover is 1in. the restraint of the steel on the outside concrete layers is very much less than when the cover is, say, ¼in., with the result that the cracking stress will be more in accordance with that calculated. These experiments therefore appear to explain the high cracking stresses observed by many experimenters.

An important question in practice is the effect of the permanent set in the steel on the limiting creep in the concrete in compression and of the plastic strains on any readjustment of the positive and negative bending moments in statically indeterminate structures. As already indicated from lines 24 and 64 in Figs. 5 and 6, the steel on no load exerts a restoring force on the concrete. Consequently on no load a considerable recovery will take place, this effect increasing with increase of the permanent set in the steel strain. The influence of this set must be present whether the beam be unloaded or loaded, and since the arm of the internal couple, from Table I, remains sensibly constant, it follows that this permanent stress in the steel prevents much further increase in the creep or flow in the compressive section of the concrete. One might state then that the plasticity of the concrete causes the steel stress to creep, but the latter in turn tends to limit the concrete plastic flow. It appears, therefore, that there is a tendency of self-preservation in reinforced concrete and that the safety of a reinforced concrete member in bending remains unchanged by these time effects. The experiments also indicate that plastic flow causes progressive changes in the concrete strains, but cause little or no difference in the moment distribution, it being always possible to balance the moment of resistance against the bending moment. Experiments, however, now in progress show that plastic strains produce considerably higher stresses in the compression reinforcement than in the tension reinforcement of a doubly reinforced concrete beam. There was no evidence to show that plastic flow in statically indeterminate structures causes a redistribution of the bending moment tending to relieve the overstressed parts of the structure. Equalisation of the stressed conditions in a manner resulting in relief of the overstressed parts of the structure, so that the material originally less stressed carries a higher load, appears to be possible only with a structural material having properties such as those of steel.

The author's thanks are due to the University of Leeds and to Professor W. T. David for assistance and facilities to carry out this work.

[6] Emil Mörsch. Der Eisenbetonbau.
[7] British Association "Proceedings," 1932.
[8] Marsh and Dunn. "Reinforced Concrete."

Obituary.

JORGEN BJORNSTAD.

THE profession of mechanical engineering has lost one of its outstanding members in the death of Mr. Jörgen Björnstad, the superintendent engineer of the Pulsometer Engineering Company, Ltd., of London and Reading. Mr. Björnstad, whose death took place at his home in Reading on January 19th, was born in 1868 in Norway, and received his technical training in that country. In 1890 he joined the Erith Ironworks of Easton and Anderson, Ltd., as leading draughtsman on the introduction of a countryman, Mr. John Bull, who was then perfecting his well-known alloy, Bull Metal. His capabilities as a mechanical engineer soon became apparent, and within a very short time he was appointed chief designer to the firm. In that position he was responsible for the whole of the machinery produced by the firm, which at that time included a large amount of gold-mining plant for the South African Goldfields. Other plants included drainage pumps for Great Britain and abroad, and the large passenger lifts of the old City and South London Railway, many of which are still in operation. Both the mechanical and electrical apparatus for these lifts was designed and patented by Mr. Björnstad. In 1894 he became chief draughtsman to the company's successors, Easton, Anderson and Goolden, Ltd., and shortly after, in 1899, works manager of the Erith Ironworks. About this time his firm acquired the exclusive licence for superheating for stationary engines under the Schmidt patents, and many engines, both with direct and indirect-fired superheaters, were designed by him and put to work, both in England and Scotland. In 1904 he joined the reconstructed firm of Easton and Anderson as partner with charge of the mechanical work of the firm. In 1909, when the business and the Erith works of Easton and Anderson were acquired by the Pulsometer Engineering Company, Ltd., of London and Reading, Mr. Björnstad was appointed superintendent engineer of the company's Nine Elms Ironworks at Reading.

Throughout his career Mr. Björnstad was a prolific designer, and many of the new types of Pulsometer centrifugal pumps were invented by him, among which we may perhaps mention the Stereophagus pump, which he produced in collaboration with the Hon. R. C. Parsons. He was a valued member of the Institution of Mechanical Engineers, the Institution of Electrical Engineers, and the Verein Deutscher Ingenieure. Besides being an engineer and inventor of outstanding ability, he had a happy manner which made him popular with his staff and men, for whom he always found time for a cheery or helpful word.

SIR WILLIAM SLINGO.

ELECTRICAL engineers will learn with regret of the death of Sir William Slingo, a telephone, telegraph, and wireless engineer of unsual ability, who for many years was Engineer-in-Chief of the Post Office. He died on Saturday, January 19th, at the advanced age of seventy-nine, at his home, Reid House, Brampton-road, Forest Hill. With characteristic energy and enterprise Sir William had arranged, and was looking forward to, a cruise up the river Amazon next month.

He was born in London in 1855 and at the age of fifteen entered the Central Telegraph Office as a clerk. When only twenty-one years of age he founded the Telegraphic School of Science at the General Post Office, and later became its principal. It started with only five students, but in 1898 had no less than 850 students, and its growth was such that it had to be closed and its work assigned to other institutions. In these years William Slingo found time to become head of the electrical department of the People's Palace in Mile End-road, to be principal of a technical college at Dover, and a consulting engineer to the Drapers' Company and other concerns. He was for some time editor of *Knowledge*, and in 1890 collaborated with Mr. A. Brooker in the preparation of "Electrical Engineering," a textbook which ran through many editions. In 1898 Mr. Slingo was appointed first-class technical officer of the Engineering Department of the Post Office, and five years later became Superintendent Engineer of the North Wales District. In 1910 he returned to London and the following year was appointed Assistant Engineer-in-Chief of the Post Office. In connection with the transfer of the undertaking of the National Telephone Company to State ownership Mr. Slingo organised and supervised an official inventory and took a leading part in the arbitration proceedings, making a name for himself on account of his deep knowledge of the situation and his firm and fair dealing. In 1915 his national services were rewarded by a knighthood. The later war years and the post-Armistice reconstruction proved difficult for the Post Office, and many of Sir William's plans had to be postponed. He retired in 1919, and one of his first undertakings after leaving the Post Office was to supervise the laying of a British-made telephone cable from Havana to Key West. Shortly afterwards the Marconi Company sent him out to Peru to investigate proposals under which the company later entered into a contract with the Peruvian Government to undertake the administration of postal telegraphs and wireless services for twenty-five years. For three years, 1921 to 1924, Sir William Slingo was Administrator-General under this scheme. On his return to England he was elected to serve on the board of Marconi's International Marine Communications Company, Ltd. Throughout a long life Sir William retained a mental vigour and geniality which endeared him to all with whom he came into contact in national and private services.

HENRY ASHMAN REED.

IT is with deep regret that we have to announce the death in Chelsea, on Monday, January 21st, of Mr. Henry Ashman Reed, a valued member of the Council of the Institution of Civil Engineers, who for the last five years occupied the position of consulting engineer to the Manchester Ship Canal undertaking, of which he was chief engineer for many years. Mr. Reed was born in Bristol in 1866 and received his education at the Bristol Merchant Venturers' School and the University College of Bristol. On leaving college he was articled to the late Mr. Charles Richardson and worked on the design and construction of the Severn and Patchway tunnels. From 1887 to 1894 he was contractors' engineer on the construction of the No. 7 section of the Manchester Ship Canal. In the following year he was engaged in a similar capacity on the extension of the Great Central Railway from Leicester to Rugby, in 1896 to 1907 on the Gibraltar docks and harbour works, and in 1907 on the Southampton deep-water dock. For the following three years he served as engineering inspector to the Local Government Board.

In 1912 Mr. Reed was appointed chief engineer of the Manchester Ship Canal, and he held that responsible post until April, 1930, when he was succeeded by Mr. F. B. Greenwood and became consulting engineer to the company. During his term of office Mr. Reed was responsible for a large amount of development and constructional work, which included the deepening of the lower reaches of the canal and the construction of the Stanlow oil dock, No. 2 grain elevator, the new transit sheds, and other works. His wide experience on harbour, dock, and canal work gave him an authoritative position on dock work, and he served on many international commissions and committees. At the request of the British Foreign Office he became a member of the British Technical Committees which in 1924 and 1929 inspected the Rhine under the terms of the Treaty of Mannheim, 1868. During the war he advised the War Office on the port of Richborough scheme. In 1928, on the invitation of the Egyptian Government, Mr. Reed visited Egypt as an advsory engineer on waterways, and the following year he was appointed a member of the International Commission on the River Congo for the Belgian Government. As late as 1932 he was appointed representative of Great Britain on the Permanent International Commission of Navigational Congresses, and he served, together with French, German, and Dutch colleagues, on the committee appointed to prepare a technical dictionary dealing with maritime and river works and their design, construction, and maintenance. In connection with the Navigation Congress he visited Venice and Cairo, and for some years he was a member of the Consultative Working Commission of the Suez Canal Company on behalf of the British Government. Despite his many duties, Mr. Reed found time to contribute much to technical literature, and in 1928 he delivered the Vernon Harcourt Lecture. He was a member of the Institution of Civil Engineers, the Institution of Mechanical Engineers, and the Association of Consulting Engineers.

Rail and Road.

ACCORDING to the Board of Trade export tables for December, the value of the railway material shipped overseas during the whole of the year 1934 was as follows, the corresponding figures for 1933 being added in brackets: Locomotives, £453,290 (£734,428); carriages and wagons, £973,853 (£527,291); rails, £996,044 (£481,837); wheels, metal sleepers, fish-plates, and miscellaneous materials, £1,212,042 (£838,490).

ACCORDING to the Rundschau Technischer Arbeit, there are now under construction at the Borsig Locomotive Works, Berlin, two streamlined locomotives with a designed speed of 175 kiloms., or about 108 miles per hour. The diameter of the driving wheels is given as 2·30 m., or 7ft. 6⅝in., which is stated to be the largest yet used on German locomotives. Three cylinders are used and the length of the locomotives is 25 m., or about 82ft.

WE have to record with regret the sudden death on January 16th of Lord Knutsford, the twin and younger brother of the well-known chairman of the London Hospital, and, until the death of the latter, Mr. Arthur Holland-Hibbert. He became a director of the London and North-Western Railway in 1880, when only twenty-five years of age, and with his subsequent service on the board of the London, Midland and Scottish, was a railway director for fifty-five years.

THE L.M.S. Railway reports a fast run between Bletchley and Euston by "The Royal Scot" express from Glasgow and Edinburgh to London. Making a special stop at Bletchley to take water, the train, which consisted of thirteen coaches, weighing 443 tons, hauled by the 4–6–2 locomotive "The Princess Royal," covered the 46¼ miles from Bletchley to Euston in 46 minutes, inclusive of 2 minutes' delay by signals. An average speed of 78·9 m.p.h. was maintained over the 26¼ miles between Tring and Willesden.

THE first section of Victoria Station, Manchester, so named after Queen Victoria, was opened in May, 1844, and consisted of the bay lines on the south side of the present station. On July 1st, 1860, the station was enlarged on the north side by the addition of what was then known as Nos. 5 and 6 platforms—now designated Nos. 11 and 12. Between the two platform lines were two main lines for the London and North-Western trains from and to the adjoining Exchange Station, and a carriage siding. These five roads were under one roof, which now, after seventy-five years' service, is to be taken down. A verandah will protect the platform roads, but the other lines will be in the open and thus admit more natural light into the station. The work is being done by the L.M.S. Company's own staff.

THE following statistics as to the use of steel in the passenger stock of the London, Midland and Scottish Railway are reproduced from Colonel Trench's report on the Winwick Junction accident. For many years past the standard practice of the company, as also of the other main line companies, has been to construct all new passenger stock of heavy steel underframes. Of the L.M.S. stock approximately 80 per cent. is now of this type, and during the last six years the bodies of these underframes have had steel ends and steel panels on timber framing; their number is approximately 2300. Since 1932 the roofs also have been of steel; some 1200 have been so treated, and about 600 vehicles are provided with steel roofs each year. Of the total weight of the latest coaches of all four main line companies, about 75 per cent. is steel.

SOME changes of note were made on January 1st in the staff of the chief engineer, Southern Railway. Mr. G. A. Linton, hitherto "London, East" Divisional Engineer, has become Assistant Engineer (General Maintenance), and Mr. F. E. Campion, Assistant to the Chief Engineer, goes to London Bridge to succeed Mr. Linton. Whilst Mr. Linton has had a varied experience, particularly in engineering works during the war, he was in the engineering department of the South-Eastern and Chatham when the Southern Railway was formed. Mr. Campion comes of an old railway family. His grandfather, Mr. Fred. Campion, was the Maintenance Engineer, under Mr. Andrew Johnston as the Chief Engineer, of the whole of the southern half of the Midland Railway, and his father, the late Mr. F. A. Campion, was, until a few years ago, the Chief Engineer of the Great Northern of Ireland, and was formerly on the English Great Northern. Mr. F. E. Campion served under his father and Mr. C. J. Brown in England, and then under the former in Ireland, and in 1920 joined the London, Brighton and South Coast. Mr. W. A. Messer, permanent way assistant to the Southern Chief Engineer, retired on December 31st.

THIRTY years ago—on January 19th, 1905—a collision occurred which gave considerable concern to railway signal engineers and operating officers. A dense fog prevailed and in it the Midland Company's up night mail from Leeds was run into by one of the night Scottish expresses just south of Cudworth, and five passengers and two servants were killed. There were a series of short block sections through Cudworth, and, under the rules for short-section working, each box must have its distant kept "on" as long as the distant for the box in advance is "on." Thus, in a series A, B, C, D, E of short sections, the distant for D repeats that for E; equally when A has its distant "off," those for B, C, D, and E should be at "clear." Carlton Main distant was the key signal on this occasion, and the driver of the express said that his fireman indicated by a wave of the hand that the signal was "off," which meant that he had a clear road through Cudworth. As the fireman was killed, he could not corroborate the driver's story, but not only was Carlton Main distant "on," but so were seven successive distants and five stop signals, all of which the driver, in the fog, failed to see. Because it was the key signal, Carlton Main distant was the only signal for which a fog signalman was appointed, and, by a combination of unfortunate circumstances, that man was not at his post when the express passed. Among the comments made by Sir John Pringle in his report was one to the effect that it was not clear that the possibility of replacing the manual system of fog-signalling by one or other of the more promising inventions of cab-signalling had received sufficient consideration at the hands of railway companies generally.

Miscellanea.

THE new Swansea power station at Tir John North is to be opened on April 18th next.

A NUMBER of big schemes for bridges in Holland are to be accelerated and the works to be completed in seven years.

COAL and coke shipments from the Tyne during 1934 totalled 14,080,816 tons, an increase of 1,137,767 tons over 1933.

ELECTRICAL imports and exports of this country during 1934 were valued at £3,555,857 and £11,305,224 respectively.

IT is probable that Sir Malcolm Campbell will make his attempt to attain a speed of 300 miles per hour with his motor car on Daytona Beach, Florida, on February 18th.

THE machinery exports of this country for 1934 are valued at £32,810,462, an increase of £5,667,176 on the previous year. During the year machinery to the value of £11,271,249 was imported.

A NOTE in the *Railway Gazette* states that the railways of Roumania and Jugoslavia are to be connected by two bridges over the Danube. The first one to be built will connect Turnu-Severin and Kladova. It will cost some £800,000 and take three years to complete.

IN a review on Post Office developments Sir Kingsley Wood stated that, in the international field, telephone communication by wireless, submarine, or land line is now possible for approximately 33,000,000 of the total of 35,000,000 telephone subscribers in the world.

ACCORDING to the annual statistical report of new companies, issued by Jordan and Sons, Ltd., there were 514 electricity, water, and gas companies with a total capital of £5,427,085 and 697 engineering concerns with a capital of £11,561,155 registered in this country during 1934.

IN a paper discussing the cadmium plating of iron and steel, Mr. W. Frölich stated that cadmium forms a layer of oxide which, although it adheres badly, protects the metal in a dry atmosphere from further oxidation. In a moist atmosphere, on the other hand, cadmium is less permanent than zinc.

ACCORDING to the returns for 1933 issued by the Ministry of Transport, the tramcars in Great Britain carried 60,000,000 fewer passengers than in 1932, there being only 135 tramway undertakings instead of 159. Trolly vehicles belonging to twenty-five local authorities and five companies carried 227,083,825 passengers, as compared with 134,182,358 during 1932.

ACCORDING to a notice in the *Electrician*, a 100,000-kW steam turbo-generator is being designed at the Turbine Bureau of the Stalin plant in Leningrad. It is claimed that it will be the most powerful of its kind in the world. The most powerful turbine so far produced by this plant has a capacity of 50,000 kW. In spite of its increase in capacity, the size and weight of the new set will not exceed that of the former, and it will operate at 3000 r.p.m.

A NEW method of surface hardening known as Chapmanizing has been developed by the Chapman Valve Company, of the United States. The process, which involves the addition of nitrogen to iron base alloys, produces a case-hardened depth from 0·002in. to 0·3in. The hardness of Chapmanized metal ranges from 700 to 1100 Brinell, the treatment causes little or no distortion, and treated metals are said effectively to resist corrosion.

DEALING with the application of taper roller bearings to rolling mill equipment, Mr. Doughty stated in a recent paper that as compared with plain bearings there is a saving of 25 to 50 per cent. in power, with a corresponding saving in the cost of motors and driving gears; also a greater output because of the higher rolling speed, an increased accuracy of product owing to the elimination of bearing wear, a longer service life, and saving in lubrication and maintenance costs.

A NEW works for the manufacture of chloroprene type synthetic rubber by a process discovered two years ago by scientists of the Leningrad Institute of Applied Chemistry, is nearly completed in Erivan, Armenia. The product, which has been named "Sovprene," is stated to have excellent wear-resisting qualities, to be practically free from deterioration through age, and to be insoluble in petrol. As a type of synthetic rubber, its chief advantage lies in its low production cost compared with the method of producing synthetic rubber from alcohol. In addition to the synthetic rubber, the Erivan combine will produce lacquers, paints, and building materials as by-products.

AFTER nine years' research, the National Institute for the Blind has designed a press able to take copies of Braille writing embossed on paper. In its search for some method of reproducing the dots embossed on a paper sheet of Braille, the Institute tried various devices—hardening the master sheet chemically, backing it with plaster, the electro-deposition of copper, &c.—but each failed owing to technical difficulties. At the same time, it has been necessary to introduce into the preparation of the master sheet one slight modification—the styles producing the Braille dots actually pierce the paper. During the operation of the machine, which is worked by a small electric motor, three spring-loaded styles are made to move up or down over the Braille master sheet, with the movement of which they synchronise. As the sheet comes to rest at each half character needles descend, and where punctures exist the needles pass through the paper. If there is no puncture at a particular point, the corresponding needle remains on the surface with spring compressed. When a needle passes through the master sheet it causes revolving cams to operate a rod carrying six levers, to each of which is attached a style capable of embossing a dot in one of the six sheets of paper lying in six superimposed trays. These trays move according to the movement of the master sheet below, and so allow the original embossing to be faithfully reproduced. By means of the apparatus six copies of a double-sided page of Braille can be made in about twenty minutes—an immense saving of time and mental effort compared with that expended under the old manual system.

Air and Water.

AN air line connecting Brussels, Ostend, and Lille is to be established this year.

DURING the past year 5663 vessels passed through the Suez Canal, the receipts being over 8½ million francs.

A NEW ferry boat to convey cars across Loch Linnhe between Ardgour and Corran is to be put into service.

CONSTRUCTION is to be begun on a new works at Le Mans for the manufacture of the Gnôme-Rhône aeroplane engines.

AN air liner capable of carrying some seventy passengers and crew is reported to be under construction for Imperial Airways.

DURING 1934 over 100,000 passengers passed through Croydon air port. Of these, more than half were carried by British lines.

THE mine-laying submarine H.M.S. "Rorqual," of the 1934 naval programme, is to be built by Vickers-Armstrongs, Ltd.

A TRANS-CANADA air race has been proposed for this summer. The race would be from Vancouver to Halifax, with Regina and Ottawa as stopping points.

THE new 18,000-ton passenger liner "Potsdam," being built for the Far Eastern service of the Hamburg-Amerika Line, has been launched at Hamburg.

IT is announced that the French liner "Normandie" will leave on her maiden voyage on May 20th, and will call at Southampton going out, and at Plymouth coming back.

THE River Wear Commission has asked sanction for a £350,000 scheme for reclaiming 60 acres of land from the sea adjoining the South Docks, Sunderland, and utilising the land for timber storage purposes.

THE "Imperial Star," the first of the three new Australia and New Zealand food ships built by Harland and Wolff, Ltd., for the Blue Star Line, has left for New Zealand after successfully completing her trials.

A NEW motor lifeboat is to be built and stationed at Hythe to take the place of one of the light self-righting type which has been there since 1929. New boats are also being built for the stations at North Sunderland, St. David's, and Gourdon.

IN a recent lecture given under the auspices of the London Society, Mr. J. H. O. Bunge stated that the Port of London Authority has under consideration two schemes for damming the Thames, one at Woolwich, the estimated cost of which would be £3,000,000, and the other at London Bridge, costing approximately £800,000.

IT is reported that a conference is to be held in connection with the German Luft Hansa Company's scheme for a Berlin–Shanghai air service, *viâ* India. Representatives of Imperial Airways and the big French, German and Dutch companies, will be present, the object of the conference being to avoid harmful competition in passenger and air mail service.

IT has been decided that on her westbound voyages which start at the end of May, the new French liner "Normandie," 70,000 tons, shall anchor in Cowes Roads and take on board passengers from Southampton by tender. In addition to the "Normandie," the other four French liners in service—the "Ile de France," the "Paris," the "Champlain," and the "Lafayette"—will also make their call in Cowes Roads.

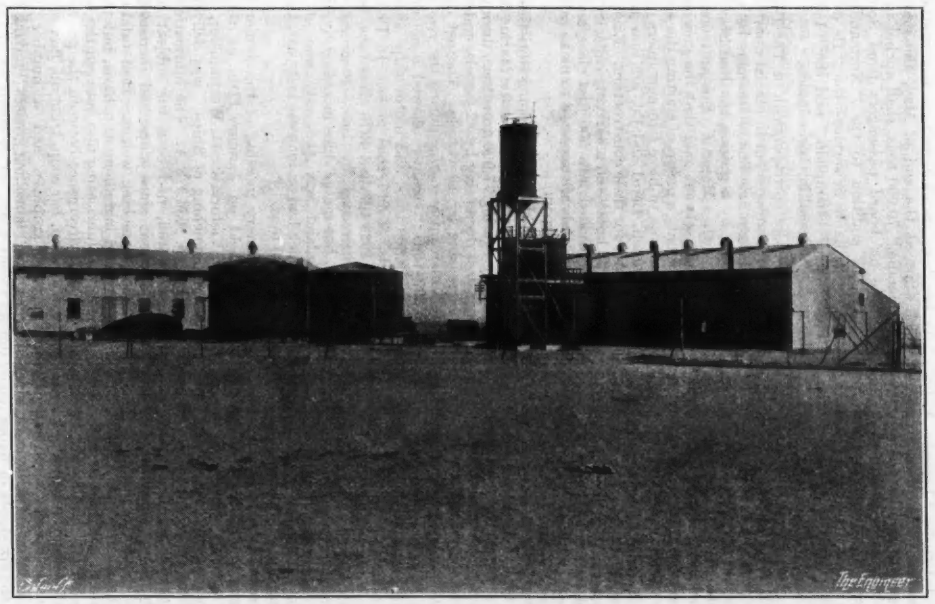
THE Liverpool correspondent of *The Times* says that, in spite of discouragement in official quarters, the scheme for establishing a new line of steamers between Liverpool and New York by acquiring the Red Star liners is being persevered with. Major F. Bustard, one of the prime movers in the scheme, said that the purchase of the Red Star liners is only a means of starting the service, and that the proposal was to have two new liners of about 28,000 tons. Cammell, Laird and Co. are now preparing plans and estimates for their construction. Each ship will have a speed of 22 knots and a carrying capacity of about 1500 passengers, divided into 500 first-class and 1000 tourist class. The vessels are expected to make sailings every ten days from Liverpool.

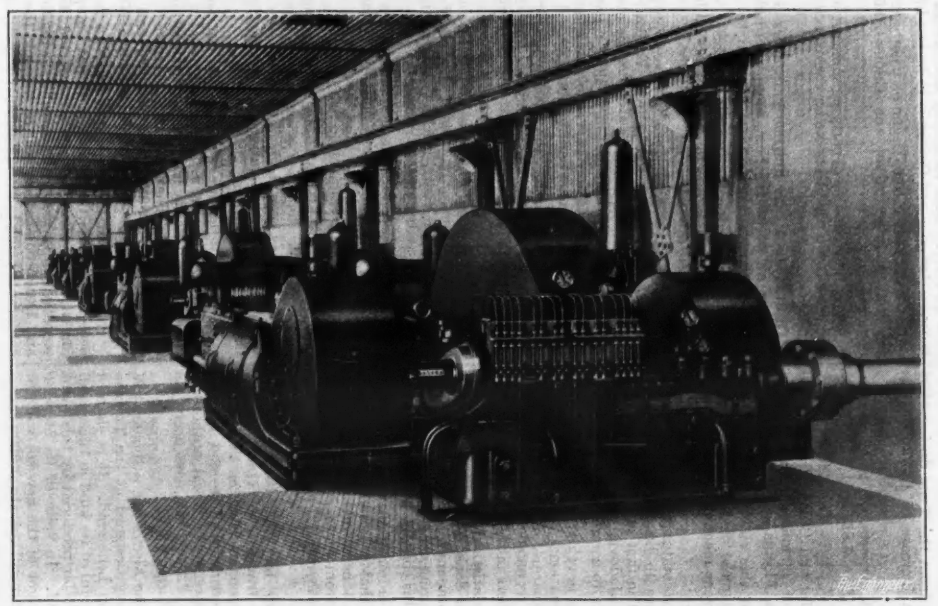
ACCORDING to the 1934 shipping statistics of the Norske Veritas, the Norwegian Mercantile Marine decreased by 72 vessels, aggregating 77,000 gross tons, during the year, the steamer fleet decreasing by 82 vessels, and the motor ship fleet increasing by 10 vessels. The net decrease in the Swedish mercantile marine during the year was 52 vessels of 50,300 tons; steamers showed a net decrease of 47, totalling 49,500 tons, and motor ships a net decrease of three vessels, of 267 tons gross. In Denmark the net decrease in 1934 totalled 4070 gross tons, but the number of vessels increased by two. Steamers decreased by 11,080 tons, but motor ships increased by 9200 tons. The fleet of Finland was the only one of the northern countries which had an increase last year, this having been one of 45,000 tons.

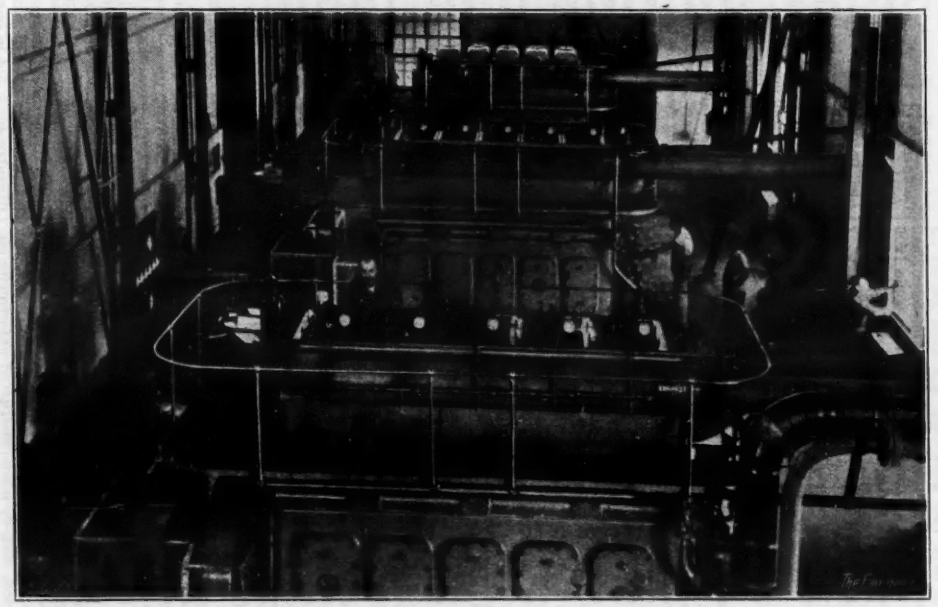
AT an ordinary meeting of the Junior Institution of Engineers, held on January 11th, at the Institution's rooms at 39, Victoria-street, Westminster, S.W.1, a paper on "The Launching of Ships," was delivered by Mr. J. Foster Petree, A.M.I.N.A. The lubrication of launching ways, he stated, had been the subject of some study and experiment since ships had increased so much in length and launching weight. Beef tallow was still the most favoured ingredient as a basis, but the composition of the actual lubricating film between the layers of tallow showed wide divergence between the practice of different yards, soft soap, bar soap, train oil, flax seed oil, lard oil, axle grease, graphite, and a number of proprietary stearines and "launching greases" having been employed during recent years, either singly or in various combinations with each other, and with remelted tallow from previous launches. It was observable, also, that the quantity used per square foot had been increased considerably in the cases of the longer liners and warships, although unit static loadings had risen but little in the last half-century and, within wide limits, were almost independent of the size of the ship.

PUMPING STATIONS ON THE IRAQ PIPE LINE

(For description see page 91.)







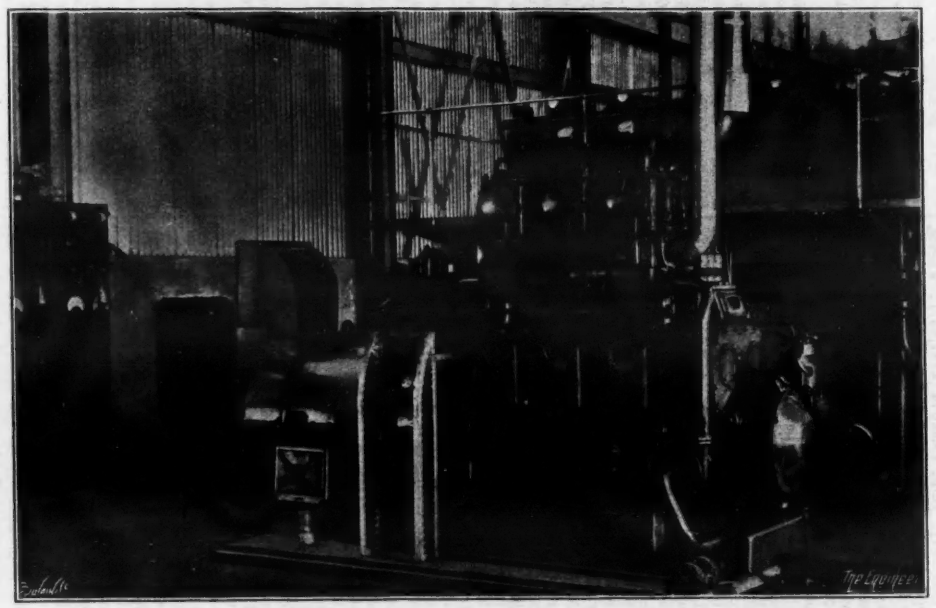


FIG. 9 (ABOVE):—A TYPICAL PUMPING STATION

FIG. 10 (ABOVE):—OIL PUMPS AT K 3 STATION

FIG. 11 (BELOW):—MAIN ENGINES IN "T" STATION

FIG. 12 (BELOW):—OIL ENGINE-DRIVEN GENERATOR

The Engineer

JANUARY 25, 1935.

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Contents.

THE ENGINEER, January 25th, 1935. PAGE

A SEVEN-DAY JOURNAL ... 87
THE DEVELOPMENT OF PARSONS INDUSTRIAL TURBO-MACHINERY. No. III. (Illus.) ... 88
THE IRAQ PIPE LINE. No. II. (Illus.) ... 91
STRAIN AND STRESS DISTRIBUTION IN CONCRETE BEAMS. (Illus.) 94
OBITUARY—
Jorgen Björnstad ... 96
Sir William Slingo ... 96
Henry Ashman Reed ... 96
ROAD AND RAIL ... 97
MISCELLANEA ... 97
AIR AND WATER ... 97
LEADING ARTICLES—
Saar Reactions ... 99
Good-will and Ill-will ... 99
THE SELECTION OF A FACTORY SITE ... 100
THE LATE CHARLES DAVID DOXFORD ... 101
SIXTY YEARS AGO ... 101
SHORT CIRCUIT TESTING INSTALLATION. (Illus.) ... 102
CHANGE OR DECAY ... 103
A NEW BOILER FOR LEICESTER POWER STATION ... 104
SODIUM-COOLED VALVES. (Illus.) ... 104
THE RECTOPHOT ... 104
TWO NEW MACHINE TOOLS. (Illus.) ... 104
A LARGE HONING MACHINE. (Illus.) ... 105
A CABLE TRACER AND FAULT LOCATOR. (Illus.) ... 105
AN HYDRAULIC TOWER WAGON. (Illus.) ... 105
LETTERS TO THE EDITOR—
Finance and Individualism ... 105
LIQUID RESISTANCE FOR 4200 KW. (Illus.) ... 106
BRITISH STANDARDS INSTITUTION ... 106
THE E.M.F. BETWEEN METALS IN SEAWATER. (Illus.) ... 107
PROPHETS AND PANACEAS ... 107
LARGE AMERICAN TOLL BRIDGES ... 108
PERSONAL AND BUSINESS ANNOUNCEMENTS ... 108
CONTRACTS AND ORDERS ... 108
MARKETS, NOTES AND NEWS ... 109
CURRENT PRICES FOR METALS AND FUELS ... 110
FRENCH ENGINEERING NOTES ... 111
BRITISH PATENT SPECIFICATIONS. (Illus.) ... 111
FORTHCOMING ENGAGEMENTS ... 112
CATALOGUES ... 112

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SAAR REACTIONS.

Now that political events in the Saar have become less disturbed and the ownership of the territory has been decided, it is possible to consider some of the industrial and commercial results of the plebiscite. Apart from the financial and currency adjustments which will be necessary in the transfer of the administration from the governing commission of the League of Nations to the German Reich, the return of the coal mines and iron and steel works may have complicated repercussions on the world's markets for these materials. Lying, as it does, in a corner between the industrial districts of Alsace Lorraine, Luxembourg, and the Rhineland, its natural markets so far as coal is concerned are close at hand, but have the grave disadvantage that they are barred by frontiers with their inevitable Customs walls. Until the result of the plebiscite was known political considerations to some extent neutralised these disadvantages, and both France and Germany respected Saar susceptibilities by buying large quantities of coal as well as iron and steel. The position of steel, however, has differed from that of coal, as the exports to both countries are controlled by the Cartel, and by agreements between the French and German industries; but for some months past the German steel works, with surprising self-denial, have been passing large tonnages of orders to the Saar works. It was explained that these were contracts which the German works for one reason or another could not handle; but it is not difficult to find a political significance in the transactions. Now that the plebiscite has made political blandishments unnecessary, these Saar industries will have to depend to a greater extent upon the normal flow of trade, and it seems probable that some dislocation of existing conditions in the Continental coal, iron, and steel trades may result. For some time to come, also, political influences in the form of treaties concerned with the handing over of the mines and steel works to Germany will continue to affect an already complicated position.

The coal trades in all exporting countries are viewing the outlook with well-founded uneasiness. The statistics of the Saar industry show that out of an annual production of about 10,500,000 tons of coal, about 4,000,000 tons went to France and 1,000,000 tons to Germany. French consumers, by a special arrangement, were charged particularly low prices. It is very unlikely that these privileges will be continued by the Germans, but under an agreement reached at Rome last year the French are to retain the free lease of mines in the Saar producing over 2,000,000 tons per annum. With the disappearance of low-priced coal from the French market it is only reasonable to expect that the Saar imports will fall to the benefit of French mines, particularly those in Lorraine. The situation is likely to be further disturbed by an expansion in the Saar production, and the German coal industry is therefore faced with the prospect of a serious increase in offerings of Saar coal in its domestic markets. In these circumstances it seems very probable that the German coal owners will seek to improve their overseas export trade, and the prospects of unrestricted competition in these markets is causing anxiety. Under the conditions which now rule in Germany it would appear that the obvious course for the Saar coal is to be absorbed in the German market and for the more suitable German coal to be exported. The reaction upon the iron and steel markets may be less disturbing to the world's markets, but not less far-reaching, or of lesser importance to the economic structure of the European steel industries. In 1934 the Saar produced about 3,000,000 tons of iron and steel and of this quantity France took 500,000 tons under one of those trade agreements which members of the European Steel Cartel have made between themselves. By another agreement the Eastern French (which means Lorraine) and the Luxembourg works, are entitled to an export quota to Germany of 6½ per cent. of the German steel consumption. It will thus be seen that a situation of interdependence exists which should tend to keep the present balance of French and German interests unimpaired. An important factor is that France has financial interests in the Saar iron and steel industry which, it is understood, amounts to 35 per cent. The French undoubtedly are concerned as to the consequences the transfer may have upon these investments; but not more so than are the Germans as to the future of the iron ore supplies of the Saar works. It may be said that the discovery of a way to utilise the Lorraine minette iron ore brought the Saar works into existence. Before the war, when Lorraine was German, supplies were certain; while the Saar was governed by the League Commission they could be equally relied upon; but now a frontier will divide the consuming works from the ore mines upon which they depend. It has been argued that the authority of the Cartel will be sufficient to maintain the *status quo* between the principal European steel industries; but that authority has worn rather thin of late. One reason is that the Cartel agreement must be renewed in March or it will automatically expire, and behind the scenes revolts against existing conditions are taking place, such as usually occur before a trade agreement of this character is arranged. The Germans want a larger export quota and the French, Belgian, and Luxembourg steel makers refuse to have their allotments reduced. Germany demands that the steel exported by barter arrangements shall not be included in her quota; the other members of the Cartel will not agree and complain bitterly that the Germans have exceeded their agreed allotment. Now that the Saar iron and steel production must be added to that of Germany a further complication is introduced into an already difficult situation.

To find a satisfactory solution of these problems will take time, and will not be easy. The coal situation may prove less controllable than that presented by the iron and steel trades, and before it is settled, possibly by a process of rationalisation, which, it is understood, is to be undertaken in Germany, and by international trade agreements, wasteful competition is likely in some of the more vulnerable export markets. The complexities of the steel position, on the other hand, make the future course of events in the world's markets uncertain. The Saar works are not favourably situated for export, but when their order books require filling their competition in overseas markets is formidable. Much probably will depend upon how far the present financial ownership is left undisturbed. It is suggested that in the near future a struggle between conflicting interests for the control of the works may take place, and this is interpreted as a struggle between groups of financiers backed by Continental banks which already have a great interest in foreign steel works. Of considerable importance to the export market is the possibility that changes may occur in the present centralised methods of selling; although this is not generally considered likely. Probably it will be found that the most important factor in the situation is the possession by French interests of the ore supplies of the Saar steel works. To compete in the export markets cheap production is essential and the French have at least the power, if not the desire, to check Saar competition by the prices they charge for their ore. Such action is unlikely save in extreme circumstances, since it would have unfortunate repercussions upon the Cartel; but it is a possibility which cannot be lost sight of. Already in France suggestions have been made that it is time the question of conserving the minette ore resources was considered from an economic point of view.

Good-Will and Ill-Will.

FINANCIAL purists and the heads of really conservative businesses are in agreement that where there is a substantial item for good-will in the balance sheet of a manufacturing undertaking, it is best that that item should be progressively reduced until it stands at a purely nominal value, thereby forming a species of secret reserve. That, however, is a matter of form of accountancy; but, whether recognised or not, every business has a good-will value. Now, the dictionary definition of good-will is an element in the saleable value of a business, additional to the value of the plant, stock-in-trade, book debts, &c. It is platitudinous to repeat that in normal times the retention of markets depends on retention of a reputation for intrinsic quality, pleasing finish, and prompt deliveries, none of which can possibly persist without vigilant forethought, systematised control, and wise advertising. Of course, markets are lost from time to time by occurrences over which the producer or merchant has little or no control. But what of those hazarded and partially or wholly lost in normal circumstances? Some markets may be lost through inability to meet competitive prices, some through displacement by a more efficient type, and still others by "ill-will" acting cumulatively. Yet what board of directors will instruct its auditors to prepare from its books a private report (secret as regards the shareholders) of any potential ill-will accruing in the year under review? We may suppose that the average auditor would ask how this was to be assessed other than by the evidence of diminishing returns and then submit that in any event such an assessment was the work of the management. The average auditor might well go on to say that if good-will sometimes verged on the intangible, any estimation of ill-will would be still more intangible and that the computation would be merely strained empiricism. Admittedly, ill-will is an intangible entity, yet careful accountancy would serve to evaluate the various monetary factors which were available as evidence of its potential genesis, even though the constants by which these factors should be multiplied were based on little more than wild guesses.

The first question should be, what has any contract cost after the material has left the works? If a mere free-on-rail or free-on-site job, was there any transit damage which better packing would have obviated? How long did it take to secure effective beneficial replacement? Were the purchaser's indirect losses out of all proportion to the manufacturer's loss? Or, at a later stage, what was the cost of replacing defective parts, or in refuting allegations as to failure to meet designed duties, or in fulfilling guaranteed efficiencies, or in rectifying faults in erection by the manufacturer's staff? These direct after-costs in the firm's books are matters of simple arithmetic, and very tangible indeed. Then again, there is the fact of late delivery. The money deducted by enforcing penalty clauses in contracts (on the rare occasions when they are collected) is invariably a most inadequate compensation to the purchaser. Yet we suppose that all that auditors are ever aware of is the money deducted. Suppose on the other hand, any board called for a monthly return of all contracts which were at the end of a month overdue, and assessed the indirect injury to the firm's prestige at, say, one per cent. of the contract value per week on all overdue material or equipment, it would have an index as to works efficiency which is never hinted at, let alone revealed by an item in a balance sheet of value of work in hand. Let us suppose that such an era of imaginative but secret accountancy dawns. At first disturbing to complacency, it may make for an efficiency and an enhancement of the good-will value, no matter whether that good-will value has a figure set against it in a balance sheet or whether it is the good-will

assessment of the market place where shareholding changes hands at values based on past and present dividend stability. A logical imaginative secret accountancy becomes a boardroom barometer of greater value in the preparation of a chairman's address to the shareholders than the recital of the accomplished facts, good or bad, of the year under review or a reference to the order book. It is quite easy to picture a number of possible excerpts from speeches in such an era. Thus pessimistically: "A careful investigation of the operations of your works at X indicates that for reasons your board cannot disclose the losses due to defects in equipment supplied to our customers have reduced our profits by £Y. Further, your board feels perturbed by the fact that our works at V have been uniformly late in their deliveries; the resultant ill-will figure has been doubled. This is attributable in part to our suppliers of raw materials, and in part to breakdowns of our out-of-date semi-derelict tools, and/or friction with our employees." Or optimistically: "You will agree that you have good cause to be satisfied with the prospects of our undertaking when I tell you that in the year under review our auditors report that on the contracts completed during the past two years we have not been called upon to supply a pennyworth of replace parts under our guarantees; that we have not had to acknowledge, let alone investigate, a single complaint, and that the only references to past orders refer to their duplication. Further, Gentlemen, we have almost maintained our reputation for punctual deliveries. Taking 100 as the bad delivery factor for the five years preceding our accountant's report to us on contingent accrued ill-will, our figure for the year under review is 6·3 as against 4·2 last year. If the influenza epidemic had not been so severe in March, we do not think that this setback would have occurred."

Under to-day's conditions, the shareholders of, say, the Weissnichtwo Universal Bubble Company, Ltd., hearing either address, would first have to pinch themselves to be sure that they were awake, and then being assured that it was not a dream, would call for a report by a panel of alienists on the mental condition of the board. Admittedly, the brutal frankness of the first oration would cause a panic, while the optimism of the second would savour of the atmosphere associated with a wild cat prospectus. Yet about a generation ago, an English dramatist in one of his plays made one of his characters describe a financier as a pawnbroker with imagination. May we not ask how far the analyses of accountancy can be directed towards an assessment of the probabilities that in the period under review there has been an increase in the potential ill-will item which might stand on the debit side of the balance sheet? There is nothing imaginative in returns as to transit damage multiplied by a time factor covering the replacement period. There is nothing imaginative in adding up the costs of a contract after it ought to have been or has been taken over by the purchaser. There is still less imagination in a weekly return of overdue work and calculating what an hypothetical one per cent. per week would represent. Imagination would come in in its estimation of the constants to be introduced to represent the psychological reactions of the purchaser and his staff and of his and their friends. But in time these constants would become almost as actuarial a matter as an insurance risk. In any case, the secret estimation of an ill-will debit would make for efficiency. Just as good-will is diminished for the enforced reason of a series of bad years, so the secret ill-will figure would often admit of reduction as a hazarded reputation was regained and as evidence became available that the aggrieved purchaser had been pacified, or an enhanced prestige secured as the result of the manner in which accident or unexpected happenings had been met.

The Selection of a Factory Site.

By P. DAWSON, B.Sc., A.M. Inst. C.E.

PRESENT-DAY trade conditions are forcing many firms to acquire new factory sites for the accommodation of their plant and staff, either owing to the expansion of their business or new manufacturing processes rendering their existing works unsuitable. In other cases, new undertakings are springing up, necessitating the construction of new factories, and it often falls to the lot of a factory engineer to search for and recommend to his directors a new site. This is a duty not to be lightly undertaken, as once the land is bought and the factory built, disadvantages which were not foreseen at the time when the site was bought may become obvious, and may represent a hidden expenditure which will exist for all time, and which will ultimately reflect itself in the price of the manufactured product. These notes are written in the hope that they may be of service to the engineer to whose lot it falls to choose a new site. Whilst prepared primarily with a large factory in view, they are, nevertheless, applicable in a lesser degree to a smaller project.

THE SITE.

In general, it may be said that the requirements of a site are as follows:—

(*a*) It should be suitable for the satisfactory lay-out of the buildings and the processes of manufacture, and available for industrial development.

(*b*) Its area should be sufficient to allow for any reasonable expansion of the works.

(*c*) It should have good external communications for the transport of goods and *personnel*.

(*d*) External service supplies, such as gas, water, and electricity, should be easily available in the quantities and at the pressures necessary for the requirements of the works.

(*e*) Main storm-water and soil sewers should, if possible, be near the site.

(*f*) It should be freehold, and free of all encumbrances, such as rights of way and wayleaves for existing public services.

(*g*) The land should, if possible, have appreciative value.

(*h*) The purchase price of the land should be one that is well within the capabilities of the undertaking to pay.

(*i*) The type and cost of labour in the district should be suitable for the industry.

(*j*) The ruling climate and the type of neighbouring factories should also be taken into account.

(*k*) The cost of raw materials into the works and the cost of the final article delivered should also be considered.

SURVEY AND LAY-OUT.

Let us consider these various points in detail. In order to prepare a preliminary lay-out, a fairly accurate plan of the site should be obtained. It is not always possible nor politic to obtain an accurate survey of the whole of the land under consideration if different ownerships are involved. In these circumstances a site plan may be prepared with a fair degree of accuracy from a large-scale ordnance map, which also gives the site contour lines. From this, a provisional lay-out scheme of the works can be prepared. In doing this consideration should be given to the proposed site level, gradients of roads, railways, &c. The question of the subsoil and foundations should be carefully examined, as it may easily turn out that a very desirable site may involve the buyer in such costly engineering works in making foundations that its ultimate cost from the point of view of the finished plant is prohibitive. It is not proposed in this article to go into a lengthy discussion on foundations, but the following remarks may be suggestive. Whilst the ideal foundation, of course, is rock, it may be very uneven, and although excavation may be a simple matter at one corner of the land, it may be a very different proposition at another corner. The drainage of the site and the construction of pipe and cable tunnels may also involve the purchaser in some pretty costly excavation work. On the other hand, a good hard clay foundation may be very treacherous under heavy loads, especially when the underlying strata are sloping, and is liable to cause bad cracks in very dry weather. In the winter it tends to flow under any very heavy dumps of material. Made-up ground, unless of very long standing, should be avoided at all costs, and if the chosen site is near a river in a populous district, a useful search might be made in any old maps or records, which are often available at local libraries or museums, to see whether any stream or river has at any time flowed through the site, and is not shown on present-day maps. The contours of the land may have a considerable influence on the choice of the site. On first thoughts, it may appear that a level site is best; this is not necessarily so. Very often this type of ground is made-up land; moreover, in certain works it is better to have some portion of the works on a lower level than others; works shunting may be easier, and the drainage question may be simplified. Usually a low-lying portion of the land keeps the rest of the ground much drier. If excavations are involved, and they always are to a great extent in factory construction, a tip has to be found and paid for to accommodate the surplus earth, and it is just as well to improve your own land for nothing rather than pay for improving someone else's land. Again, a low-lying portion of the land represents a very desirable dumping ground for the accumulation of boiler ashes and trade wastes when the factory is in operation. Care should, of course, be taken in certain townships to check that the land is situated on an area which has been set aside for industrial development.

Next, the site should be sufficiently large to accommodate any future extensions which can be foreseen, and in preparing any provisional lay-outs, a long view should be taken, and the ultimate plant planned for at the time when the choice of the site is made. The ground so bought can be conveniently used as a sports ground, or be let out for grazing purposes. If the site is well chosen, it will always represent a valuable asset of the company. Sometimes it is not possible to buy all the land that is required at the time, and by means of delicate inquiry it should be found out whether the additional land is likely to be available at a later date, as there may be some legal or other obstruction which prevents its purchase.

TRANSPORT.

As regards external communications, this question involves the consideration of approach roads to the site as a means of transport. They should be wide enough and strong enough to take the company's usual goods traffic, and also to discharge in the evening the factory *personnel*, including the individuals who come by car and bicycle. Traffic in the morning, owing to the difference in works and office hours, is not so serious. The routes by which road transport will come should be studied, as it may be that, owing to low underbridges, narrow roads, or light overbridges, heavy lorries cannot approach the works except by a very circuitous route. The engineer should go warily in cases of sites where the external roads are not made and projected development schemes are being considered. He may be shown grandiose schemes of town developments which are to be put in hand immediately, but these are sometimes shelved and he may find himself involved in the purchase of extra land in order to construct a good road at additional expense to the property, and during the construction period have to pay some adjoining owner so much per load in order to get his material on to the site. For this reason, the site should, if possible, have access to two different roads. Obviously the ideal site would be one having communication by road, railway, river or canal, and in the case of some industries, by sea.

The advantage to be gained by having access to a river or canal should, however, be accepted with reservation, especially in the case of the latter. There is a definite advantage in having a site on a navigable river in certain industries, as it affords a cheap means of transport for coal, and various other materials, and so may enable cheaper rates to be obtained from the railway companies; but such sites are usually dearer to buy and foundations and similar troubles are usually encountered. Therefore the advantage to be gained from such a site should be very carefully studied. In regard to canal sites, a study should be made to determine just how much material will be water-borne—in practice it is not even certain that coal will come this way—at any rate, in the South of England, owing to the unreliability of service. Again, permission is not always available to take water for cooling purposes, although in some cases this does not present any difficulty, the charge being based on so much per kilowatt generated. In the case of a river there is always the Fisheries Board to consider, which, where water is returned from process work into the river, may insist on an expensive purification plant being installed. Again, the cost of a wharf, barge bed, and unloading crane is involved. Sometimes land on the banks of a river or canal has been used as dump for refuse. This is a frequent source of vermin and rodents, which will be objectionable and difficult to get rid of when the factory is in operation if the land is situated anywhere near such a dump.

RAILWAY COMMUNICATIONS.

A site near the mouth of a river may cause an engineer to give considerable thought to the question of painting at a later date owing to corrosion. In addition, there is always the liability of fogs rendering all outside work almost impossible, and holding up all outside transport work. As regards railway communications, one often sees advertised "Buy sites on the Railway," but, having bought a site on the railway, it will sometimes be found that although the railway companies are bound to give siding facilities to anyone who asks for it, it is left to them to decide at what particular point in their system the connection shall be made. Thus, after numerous delays and conferences, the purchaser may find that having obtained the railway company's agreement to give siding accommodation, he will have to pay very heavily for it, and probably find that the bulk of what he is expected to pay for, including one or two bridges, is not his property. The actual facilities provided by the company may be anything but convenient for his traffic, and lastly, he may find the actual rebates gained by him are not commensurate with his expenditure. On the other hand, a siding is necessary to certain industries, and it should be remembered, where motor transport is relied upon solely, that lorries have to be cleared immediately, necessitating storage space and staff, whereas, in the case of railway wagons, the goods can be left in them and cleared at leisure within three days, except

when the wagon is to be loaded out again. Assuming that a siding is judged necessary the following observations may be useful. If the projected site is on a main line, usually the up and down fast is on one side of the track and the slow tracks on the other. It is useless to expect the railway company to make a siding connection off the up and down fast side, because it will not. Usually private siding connections are taken from a point where a goods loop occurs by means of a locked switch, the key of which is kept in a nearby signal cabin. The engine driver must obtain this key from the signal-box before he can enter the siding. This means that the siding connection must be near a signal-box and within view of the signalman, or else be made from the nearest railway company's siding. To do this may involve the construction of about a mile of siding track with perhaps an overbridge across some road. The cost of all this will have to be borne by the purchaser, including the maintenance cost. Again, it is not usually possible to get a siding connection off the outside of a curve.

POWER SUPPLY AND SERVICES.

Coming now to the question of external power supplies, these may be the ruling factor in deciding the choice of a site. It is obviously an advantage to have a good supply of town gas at a suitable pressure near the site, and it will usually be found that gas undertakings are willing to do all in their power to help a prospective customer buying in large quantities. It should, however, be ascertained that they have the necessary plant to meet the estimated demand at all times, and that the pressure they state is one that can be constantly maintained by them. Naturally the advantage of taking such a supply, as compared with a gas generating plant, should be studied. Electrical supply, if the grid system is available, should present no difficulties, but if the local company is a private concern, more care should be taken to see that it is capable of giving the necessary supply at all times at the stated tension, and that the service is reasonably free from breakdown troubles. The cost of such a supply should be carefully considered as against generating electricity in the factory. This question turns upon the nature of the industry and the size of the undertaking. Water, again, should be available near the site, but it will often be found that the water companies are not as ready as gas undertakings to welcome a new customer imposing a heavy demand on their already, in many cases, overtaxed systems. The pressure available should be established, especially where sprinkler and fire-protection systems are being installed, and if the pressure in the main is boosted by local pumping, it should be ascertained whether this pressure is constant at night, as serious trouble may be encountered should a fire on the premises happen at night or during the week-end when the pumping station may be closed down. This may mean that an expensive fire pump, elevated tank, &c., may have to be installed. The possibility of an alternative source of supply should also be investigated. The question of obtaining a cheap supply by means of an artesian well is worth considering. Usually, particulars of other wells in the district are obtainable, from which sufficient data may be drawn to estimate the advantage or likelihood of such a supply. In the latter case a large storage reservoir should be considered as part of the system. Again, the quality and hardness of the water require to be ascertained, as, in certain industries such as breweries and dye-works, they may be ruling factors in the choice of a site. If the proposed factory does not generate its own electricity and only uses process steam, the bulk of which is returnable to the boiler-house as condensate, then this question is not as important as in the case of a works generating a large amount of electricity and also using a large quantity of non-returnable steam. The boiler-house is a factory for the making of steam, just as much as the rest of the plant is a factory for making goods, and should be treated as such.

The local Council should be approached, as even if its sewers pass near to the site it is not at all certain that a factory drainage system of any magnitude can be discharged into them, as they may already be overloaded. This may mean considerable expense in the case of some sites in order to get rid of the storm water and sewage; in some cases it may be necessary or economical to put in a private sewage disposal plant in order to avoid a nuisance. The question of trade wastes disposal requires to be looked into, as some Councils object to these running into their systems owing to trouble being caused by them at the sewage farm. Where the site is situated on low-lying flat land, particularly near a river mouth, very often the sewage and storm water is pumped, in order to dispose of it. It may happen that during heavy storms, at the time when it is most needed, the pumping station may break down and the site be flooded, thereby causing extensive damage.

TITLE DEEDS.

The question of freehold is obvious, but it is as well to mention that a careful search should be made into all the title deeds. Leasehold land should as a rule be avoided owing to the restrictions often imposed and the heavy ground rent, and also the necessity of keeping the buildings up to the standard demanded by the ground landlord, as in a factory the wear and tear of buildings is much greater than in any other property. Again, if for any reason it is necessary to dispose of the plant, buildings and site, freehold property is more easily sold than leasehold property. The land, of course, should be free from all tithes and other charges. With respect to rights of way, a search should be made into this question, as there is little chance of stopping a right of way if the local inhabitants choose to fight the question. The average Englishman is a strong believer in his rights, and to deflect, even by a few yards, a footpath which may only be used by one man once a day may cause high feeling in the district. Moreover, sites which adjoin footpaths which are not frequently used are always a source of nuisance in regard to fencing and the prevention of petty pilfering by people passing material over to friends on the footpath, or to small boys and other individuals getting into the works and causing malicious damage. The same trouble will also occur during the time of strikes. In certain cases public services, such as water mains, may pass through the site; no buildings can, of course, be built over these, but, on the other hand, the site may be laid out to avoid this; but it is usually part of the agreement that if the land has to be disturbed owing to burst pipes or other causes then the companies are only liable to reinstate the land in the condition that it was at the time when permission was granted. Thus, if any roads were to be constructed over such services by the occupier of the land at a later date, then not only would the road traffic be disturbed, but the firm would have to bear the cost of the reinstatement of the road. A similar remark also applies to sewers. Whilst these can often be diverted without undue trouble, the cost falls upon the land.

APPRECIATIVE VALUE AND PRIME COST.

The land should have an appreciative value; this point seems so obvious that it hardly needs stating, yet in some cases worthless land has been bought by firms to remain an expense on their hands, whilst in others land has been wisely bought by a company in the past with a view to building a future works, but owing to the township spreading or other causes it has so increased in value that it has paid the company to dispose of the land, thus reaping a handsome profit, and to buy land elsewhere.

Respecting the purchase price of the land, this is a question which can only be decided by the directors of the company involved. Land is, of course, a real asset and one that, unlike buildings or plant, does not ordinarily depreciate. Wise buying may mean a lot, and the practice of purchasing land in the name of private individuals ostensibly with a different object in view than that of the ultimate destination of the site has been carried out in the past by firms in order to avoid an enhanced price being asked for a desirable site. Where land is bought in lots, whilst one portion may be acquired very cheaply, the other portions necessary to complete the scheme may have so high a value as to render the total cost of the site prohibitive.

LABOUR.

The type of labour available is to a certain extent wrapped up with the question of external transport. In order to encourage the best type of workers, means must be at hand to transport them easily to and fro from the works, or alternatively the district must be such that it will supply the type of labour required, or otherwise there must be sufficient housing, either existing or being constructed, in the district available to accommodate the workers. As a last resort, if the works are on an exceptionally large scale, the employer must be prepared to undertake the establishment and financing of a housing scheme himself. This has been done by several large firms. Above all, the type of labour obtainable in the district should be carefully considered, as some districts vary greatly from others in freedom from labour troubles. Consultation with the Ministry of Labour on these points is advisable. Good female labour is more likely to be obtained in certain towns than in others where the heavy industries flourish.

METEOROLOGY AND MATERIALS.

Climate has a large effect on the output of works; everyone is more cheerful on a bright sunny day than on a cold raw misty morning, and the meteorological records of a town can with advantage be studied. Thick fogs mean late staff, trouble with outside work, congestion of road transport, whilst heavy rains may mean damaged material. On the other hand, very hot weather is not conducive to great exertion, and a long winter period with intense cold means expense in generating steam for the heating of buildings, a load which is greater than is often realised by the factory engineer. The question of neighbours also requires consideration, as certain works emit fumes which may be deleterious to the product to be manufactured.

The cost of materials delivered into the works and the cost of the transport of the finished article to its ultimate destination calls for a very careful study, as any mistake in this direction may be a costly one. The general tendency, other things being equal, was at one time to keep the works near the source of raw materials; this tendency, however, is now changing in certain industries, partly owing to the introduction of so much automatic work modifying the type of labour required; to the changed conditions of transport now that road transport is in such close competition with the railways; and to the gradual segregation of people into the larger towns and the localisation of certain industries in districts on account of their interdependence on other industries.

The above notes, whilst not necessarily complete, will, it is hoped, serve as a useful basis for study and indicate the general lines upon which the investigation of a new factory site before purchase should be conducted.

THE LATE CHARLES DAVID DOXFORD.

SHIPBUILDERS and marine engineers will be sorry to hear of the death on Monday, January 21st, at Silksworth Hall, Sunderland, of Mr. Charles Doxford, the youngest son of Mr. William Doxford, the founder of the Sunderland firm of William Doxford and Sons, Ltd., of which he—Mr. Charles—was general manager for so many years. Mr. Doxford, who was in his eightieth year, had been ill since Christmas.

He was educated at Durham and began his shipbuilding career at the age of seventeen in the drawing-office at the firm's Pallion shipyard. After five years' training he became outside manager, at the same time retaining control of the designing and constructional work of the drawing-office. In the same year—1880—when he was made a partner, his firm embarked upon the construction of marine engines, a department which was to develop and become almost as important as the shipbuilding side of the firm's activities. At that time the yard had five building slips, with a total annual capacity of 18,000 tons.

In 1891 the business was converted into a limited liability company, with the late Sir Theodore as chairman and Mr. Charles as director, still retaining his position as manager of the shipyard department. Although he was not primarily responsible for the marine engineering department, Mr. Doxford, as the general manager, took a very active part in its conduct and development under Mr. K. O'Keller, and it can be said that to him, as much as to any other person connected with the firm, its rapid progress was due. He took a prominent part in such developments as the building of turret ships in the 'nineties, and in the introduction of new processes of great importance to the industry, such as the roller press for plate joggling and in many technical questions of design and construction.

During the war Mr. Doxford devoted his energies largely to the production of naval craft at the Pallion yard.

SIXTY YEARS AGO.

A REMARKABLE illustration of the rash manner in which boilers were frequently operated in former times is provided by the circumstances which attended an explosion in January, 1875, at the chain and anchor works of Pow and Fawcus at North Shields. As a result of this accident —if that word can truly be applied to the event—seven people were killed and over twenty injured. In a leading article in our issue of January 15th, 1875, we discussed the significant features of the explosion while in our succeeding issue we reported in detail the evidence submitted at the coroner's inquiry. The boiler was of the plain cylindrical type with egg-shaped ends and had been at work since 1843. Its usual working pressure was from 30 lb. to 35 lb., but after the explosion it was found that the pressure gauge was partially choked with sand and read anything up to 20 lb. less than it should have done. Evidence was produced which showed that the boiler had given much trouble by leaking at the seams and that it had been repeatedly repaired. According to Mr. Waller, an inspector of the London Mutual Boiler Insurance Company, there were about twenty patches of all sizes and shapes on the boiler. These patches, he said, had been applied to the original plates after they had reached the limit of their age and endurance and beyond serving for a time to stop leakages of water had the effect of weakening the boiler. The condition of the boiler was so bad that it attracted the attention of the owners of adjoining property. As "friendly neighbours" they wrote to Pow and Fawcus at the end of 1872 expressing their apprehension concerning the "very rickety and alarmingly unsafe" condition of the boiler and urging them to take timely steps to avoid "a terrible explosion and consequent fearful destruction of life and property." The owners replied that the boiler was not worked at a high pressure and was in good condition. Any defect was remedied as soon as discovered for it was a loss to them if steam escaped. As yet, they said, they had not had an accident with the boiler and they hoped they would be equally fortunate in future. Their good fortune was to remain with them for about two years longer. The jury found that the boiler had exploded because it was too old and had been too much weakened by frequent repairs. The coroner, in his summing up, had told the jury that, if they saw fit, they could bring a verdict of criminal responsibility for the explosion against the owners or those concerned with the management of the boiler. But the jury did not see fit so to do. In our leading article we expressed ourselves very freely on the state of the law which absolved the owners of a boiler of responsibility for its explosion if they could establish the fact that they were ignorant of its unsafe condition. It was inexcusable in this particular case for a firm of engineers to advance such a defence in connection with an old, worn-out and patched-up boiler. In no other country in Europe would such a thing, we added, be possible for elsewhere the law determined that the owner should know very definitely what was and what was not safe. For the protection of large classes of the community we urged that inspectors should be appointed to examine every boiler before it was put down and that anyone starting or working a boiler without a Government licence should be heavily fined.

Short-Circuit Testing Installation.

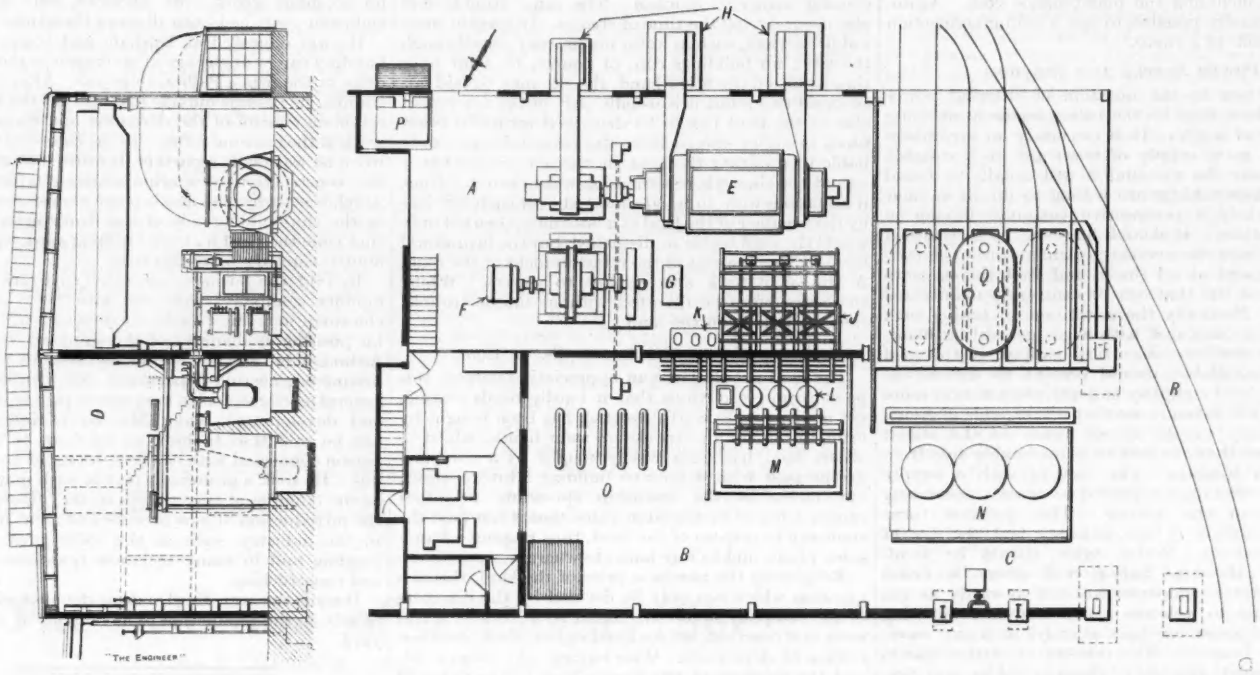
FOR reasons well known to all electrical engineers, rupturing capacity tests on heavy-duty circuit breakers, for use under modern conditions, demand the provision of special testing equipment, as described, for example, in our issue of December 30th, 1932. In the same year the Oerlikon Company, of Oerlikon, Switzerland, designed and built H.T. plant, which although primarily intended for circuit breaker testing is also employed for investigating the performance of other apparatus, such as transformers, reactances, &c., under short-circuit conditions. The building in which the plant has been erected (Fig. 1) is divided into two parts by a reinforced concrete wall, which separates the motor generator set and its auxiliaries, such as the main and auxiliary exciter, and reactances from other equipment. Reduction in reactance drop in conductors and adequate facilities for supervision, both in the machine and test departments, were the main factors governing the lay-out.

On the ground floor of the test department the incoming 6000-volt supply breaker and those for the 6000-volt motor for the short-circuit set and exciter sets (Fig. 2) are housed in separate cubicles. The control room (Fig. 3) on the floor above has a glass partition, which enables the control engineer at the desk switchboard to obtain a clear view of the testing plant in the adjoining department, whilst a view of the inner test room (Fig. 4), in which apparatus for normal pressures up to 15,000 volts is tested, can be gained through a slit in a strong steel plate. Oscillographs and other measuring instruments are in a room next to the control section. Here, again, there is a glass partition between the two departments, and a slit in the instrument room for viewing the equipment under test. Adjacent to the slit is a small panel equipped with the master short-circuit switches, and while tests are in progress the engineer standing in front of the slit and with the oscillographs close at hand, can see the man at the switch panel through the glass partition. Two telephones provide communication with outside, and the erectors in the test room. Good natural lighting is provided in the control room by the glass partition mentioned and the glass roof. Behind the oscillograph room is a well-equipped dark room, reached through a small lobby with interlocked doors which can therefore be entered when the photographer is engaged on his work. Above the oscillograph room there is an office in which the results of tests are studied. On the west side the test room opens into an extension some 30ft. long, forming an outer test section. Both sections are served by the same crane, which travels on a runway extending over the neighbouring rail track, so that gear to be tested can be unloaded directly from the trucks and placed in position in the inner or outer test room.

The test room bus-bars extend along the wall on the machine room side, and the supply circuit from the generator is led through the wall in three protection current transformers, the protective circuit breaker being inserted between these transformers and the bus-bars. In close proximity to this protective breaker is the test pit for small breakers, designed for normal working pressures up to 15,000 volts. A strong concrete wall shields the protective breaker against mechanical damage in the event of the apparatus under test failing to withstand the abnormal conditions to which it is subjected. A basin is provided for the reception of escaping oil, which is led through a pipe to a collecting duct. The many leads for measuring and control purposes terminate in the test pit on a panel with appropriate terminals, protected with a steel door. Next to the test pit there is an erection space on which switches that do not contain an inflammable liquid and other gear can be tested. A D.C. equipment installed along one wall of the building serves for testing at pressures up to 1000 volts and at currents up to 20,000 ampères.

As the test room is completely open at the west side, the possibility of the building being damaged by great differences of pressure is avoided. When testing gear to destruction a strong frame carrying wire netting and with thick wooden boards placed on two sides covers the small test pit. In the outer test room, which is reserved for tests at pressures up to 150,000 volts, the large test pit is arranged along approximately the same axis as the small pit. The transforming plant, consisting of three single-phase outdoor transformers, without expansion vessels, is mounted on the south side of the pit, in front of the machine room and behind a protective wall. Three copper conductors insulated for 150,000 volts are stretched above the transformers and test pit.

The short-circuit, 1500-r.p.m. generator, Fig. 2, is designed on the lines of a turbo-driven machine, although it is actually driven by an electric motor. Its nominal pressure and current are 12,000 volts and 3000 ampères respectively, corresponding to a rating of 62,500 kVA. As it is intended for use as a short-circuit machine the design naturally differs from that of a normal machine operating under the usual conditions. The leakage reactance is 0·192 ohm, and on a short circuit at 14,000 volts the output exceeds 1,000,000 kVA. As the excitation is slightly increased before the short circuit, the output interrupted differs but little from that prevailing at the moment the switch is closed, and as the machine can develop a peak current of over 300,000 ampères, it can be employed for determining the dynamic strength of the coils of current transformers and of isolating switches, &c. Together with the bed plate, the stator weighs 50 tons. The driving unit consists of a 6000-volt induction motor mounted on the same bed as the alternator, and to simplify the foundations, all air ducts are led out of the machine upwards. Fresh air is delivered to the machine from outside by two ducts, and having passed through Viscin filters is led to the ends of the machine. From the upper part of the alternator casing the warm air passes into the machine room. As the terminals are at the side of the generator, the conductors are led directly to the cubicles containing the reactances. The machine foundations thus take the form of a solid concrete block, which, together with about 25 tons of reinforcing iron bar, weighs about 700 tons. By means of suitable arrangements in the reactance cubicles, the generator winding may be star or delta connected, or the two sections of the winding may be connected in series or parallel. Suitable protective gear insures the generator itself against short circuits between phases and to earth. If a fault develops in the generator, all the driving motors are disconnected from the supply system and the field of the generator is de-energised. Fire-extinguishing apparatus is also brought into action and electrical braking is applied. Flaps on the air inlet ducts are closed, whilst those for the closed air circuit air circulation system are opened. The braking effect is obtained by exciting the driving motor stator with D.C., and by loading the rotor



A—Machine room.
B—Inner test room.
C—Outer test room.
D—Control room.
E—Short circuit generator.
F—Exciter.
G—Auxiliary exciter.
H—Filter.
J—Reactances.
K—Potential transformers.
L—Protective circuit breaker.
M—Circuit breaker pit for pressures up to 15 kV.
N—Circuit breaker pit for pressures up to 220 kV.
O—Test bed for water circuit breaker.
P—Starting and braking resistances.
Q—Single-phase transformers.
R—Works rail track.

FIG. 1—PLAN AND ELEVATION OF OERLIKON HIGH-TENSION TEST-HOUSE

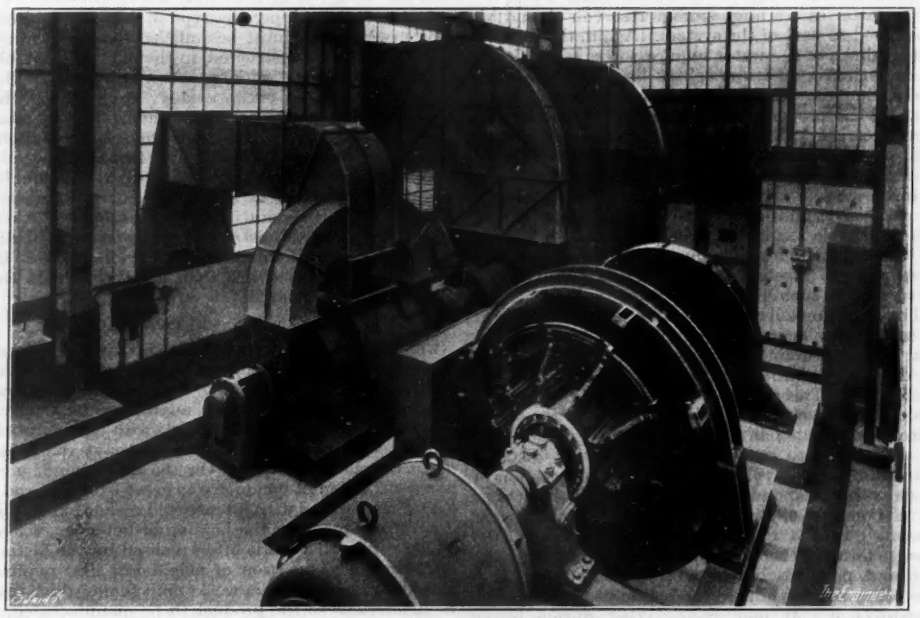


FIG. 2—SHORT-CIRCUIT AND EXCITER SETS IN MACHINE ROOM

on its starting resistance. Each time the set is started, and immediately the rotor windings have been short circuited, the starter is automatically set in the braking position ready for braking if necessary. Electrical and mechanical interlocking devices on the circuit breakers and isolating switches prevent the H.T. system being connected to the D.C. system, as the result of faulty switching. To overcome the friction of the set when starting, a rope is suspended from the crane hook and block F, which when the bridge is lifted in the direction indicated by the arrow touch the fixed contacts G. A spring secured to short arms in the levers provides the contact pressure. As soon as the contacts touch and a current flows, the well-known electrodynamic force occurs in the loop formed by the conductors in the bushing and bridge, and the force tends to enlarge the loop. As the bridge is held in the closed position by the operating gear on the breaker, owing to the unequal length of the balance

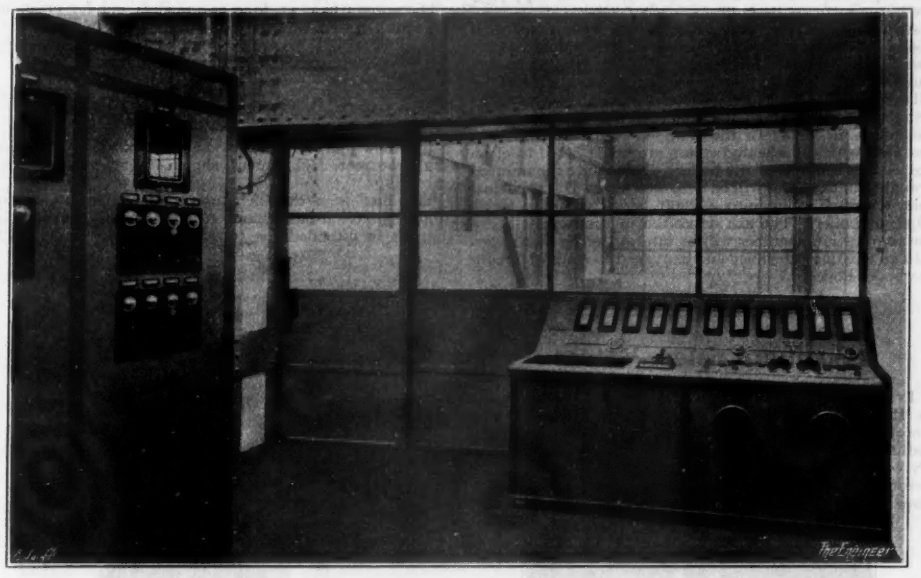


FIG. 3—CONTROL ROOM

its free end, which passes through a pipe in the floor, is wound round the coupling between the motor and generator. Thus by raising the hook the moving parts of the set are made to turn and to overcome the static friction.

While the main exciter, to be seen on the right of Fig. 2, can normally develop 800 ampères continuously, when the excitation is increased it develops ten times that current. As it has its own driving motor, it is not affected by the fall in speed of the main generator when the short circuit is applied. Before the short circuit, both sets are disconnected from the 6000-volt system, which therefore remains undisturbed and all the short-circuit output is supplied by the kinetic energy of the rotating masses, including an exciter fly-wheel. Increased excitation at the time of short circuit is secured by short circuiting a resistance in the generator rotor circuit, thereby causing the excitation pressure to rise several times. The shunt

FIG. 4—INNER TEST ROOM

winding of the main exciter is fed by the small separately excited auxiliary exciter set.

The reactances for reducing the short-circuit current are arranged for quadruple series-parallel connection and permit of output reduction in twelve steps down to 18 per cent. of the full output. They are insulated for a normal pressure of 15,000 volts, and the phases are mounted separately in concrete cells with the walls reinforced with non-magnetic metal.

The protective circuit breaker (Fig. 5) is a three-tank unit built for a normal pressure of 15,000 volts, normal current of 5000 ampères and a rupturing capacity of 1,000,000 kVA. As a rule it is used for applying short circuits, and is constructed on a special and patented principle. The centre element C (Fig. 6) is rigidly connected to the insulated rod A and serves as the bearing for the moving parts D E F. The balance levers E facing each other are electrically connected by a copper strand H. Each arm D carries a lever arms, the force increases the contact pressure, and there is no possibility of the contacts moving apart. Another advantage claimed is that the contact surfaces roll over each other and in the event of the contacts being welded at the points where they touch, they effectively

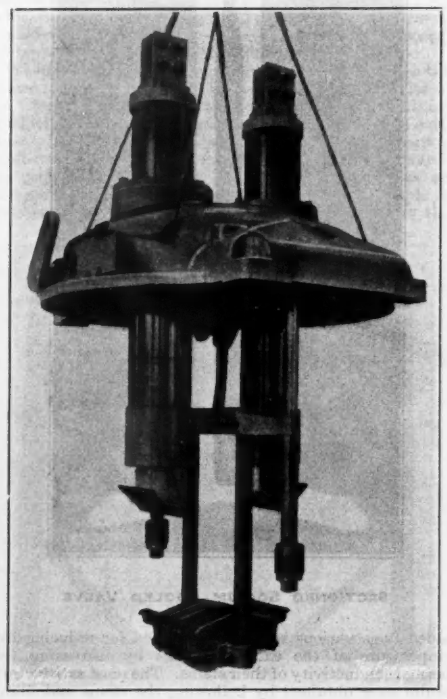


FIG. 5—SINGLE POLE OF PROTECTIVE BREAKER

separate when the switch is opened by the spring power-storage device.

The bus-bars consist of three copper conductors of 100 mm. by 10 mm. section, arranged near together to reduce the inductive drop. On account of the heavy

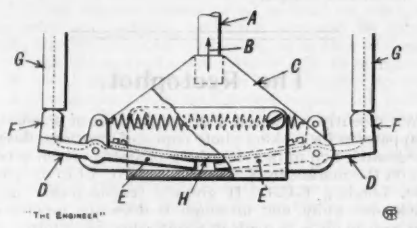


FIG. 6—CIRCUIT BREAKER MECHANISM

electrodynamic forces, they are insulated with resinous paper and impregnated wood, which is also employed for the supporting structure. A six-loop oscillograph is permanently associated with the plant, while a cathode ray oscillograph is connected up in the instrument room when required. Potential transformers and balancing resistances are provided for the pressure measurements and current transformers and shunts for current measurements.

When carrying out short-circuit tests, the reactance coils and buffer resistances are connected in circuit according to the output desired and the machines are started up from the switch desk on the remote control system. The pressure is then adjusted, but this can only be done when the key switch on the control panel next to the observation slit has been closed, as the circuit of the auxiliary exciter passes through the contacts of this switch. The short-circuit process is controlled entirely automatically by a central spring-operated control drum, which is released by the engineer at the observation slit. A series of interlocking devices ensures that all switch gear is in the correct position, while a time relay causes all circuit breakers to open after a given lapse of time, when the plant is closed down. The mechanical release of the carbonic acid fire-extinguishing device is also close to the observation slit to permit of extinguishing any fire that may occur on the circuit breakers.

Change or Decay.*

By D. A. BREMNER.

THERE never was a time, I suppose, of which we need take any account, when those engaged in industry and commerce had experienced so many changes going right to the root of their prosperity, so many changes in the methods of conducting business, and also incidentally striking at the root of the legitimate expectation of profit earning. The changes are there whether we like them or not, and they have to be accepted.

A year ago, in my address I made certain points, and expressed certain views, and I ventured in the light of the information at that time to counsel that bold courageous action should be taken. Speaking more particularly to the engineering industry, I made an appeal that we should put our house in order. Looking back a year, it is true to say that some small progress has been made in the engineering industry. I am not speaking now of technical progress, but of the organisation of the industry as a whole. I am not speaking of the increase or decrease of production and export trade. I am dealing with the organisation of the industry to study and solve the great problems which are now before it. In that direction progress has been disappointingly slow. The great problem, to my mind, the great and difficult problem before us, is to make the necessary readjustments in our industrial and commercial structure which are required to conform to and to harmonise with the changed conditions in the world to-day. We must find a method of harmonising our industry with the changes that have taken place.

We are a great nation with a great history, and we cannot separate ourselves from what is in our blood from generations past. We cannot slavishly copy other nations. We shall have to solve our problems in our own particular and peculiar way. But they must be solved. Our people would not for one moment tolerate such a thing as government by fear, such as we see in Russia. Nor would our people tolerate government by dictatorship, nor will our industries and commerce tolerate what you may call regimentation or drill-ground methods of conducting the policy of industry. We want to retain, and we must retain, the priceless asset of individualism, but that individualism, I submit to you, must to-day be so controlled as to ensure that on the whole the activities of the people are so conducted and co-ordinated as to yield the greatest net advantage to the nation. As things now stand, too many of them conflict and cancel one another out. There must be conference, agreement, and compromise. Concerns that are a menace to the industry they are engaged in must by some means or other be brought into line with the policy which is judged to be most conducive to the greatest net wellbeing of the nation. May I give you two more indications of the rate at which change is progressing? I have here Lord Melchett's Bill in the House of Lords. The preamble reads thus: "The object of the Bill is to provide for the self-government of industries by enabling a majority of producers in an industry, notwithstanding the opposition of a small minority, to introduce and cause to be enforced schemes for the reorganisation of the whole or part of that industry with the general object of promoting greater efficiency, eliminating wasteful competition, and of facilitating the production, manufacture, and supply of the products of that industry." The Council for Political and Economic Planning have also produced a draft of a Self-Government for Industry Bill. That is another straw showing how the wind blows. While this draft is admittedly tentative, and must necessarily contain many imperfections because of the lack of guiding experience, it is, nevertheless, thrown out as a proposition for study and criticism by all the interested parties.

This is a movement that cannot be stopped. We have to recognise that it is taking place and to study how we are going to play our part and to see that in the course of these changes the interests of our own great engineering industry are not neglected, but are dealt with in an enlightened and enterprising spirit. At the present time we are not well enough organised to do that. The engineering employers have developed a most elaborate and costly organisation for dealing with wages, hours of work, and conditions of work. Apparently they have placed no limit on the funds they are prepared to find in order to deal with a factor which represents on the average no more than 20 per cent. of their costs of production. But they have starved the organisation of the engineering industry to deal with trade and economic questions. The time has now come when the engineering industry must definitely make up its mind what it is going to do about it. In 1913 the total exports of British products and manufactures amounted to £525,461,000, of which £411,171,000 consisted of wholly or mainly manufactured goods made in the United Kingdom. In spite of the rise in commodity prices over the past twenty years, the corresponding

* The British Engineers' Association, January Monthly Luncheon, January 10th.

figures for 1933 were £367,424,000 and £280,441,000 respectively. In other words, our total exports dropped 30·1 per cent. and our exports of manufactured articles 31·9 per cent. That is the kind of progress we have made since 1913.

Now, as a further means of bringing the position home to ourselves, let us look at the development of the secondary industries in our Dominions. Take the case of Australia. The estimated value of Australia's production of manufactures in 1931–32 was £106,456,000 out of a total production of £305,018,000. Although this was substantially below the figures for 1928–30, it compares with only £38,986,000 in 1912, when the total production was £175,078,000. Roughly, £106¼ millions, compared with £39 millions twenty years ago. This big expansion was made possible by the increase in plant, buildings, and machinery from £69,338,000 to £228,120,000. That is what you are up against.

When I prepared a monograph for the World Economic Conference at Geneva in 1926 I ventured to say something like this. I said it is no use expecting our Dominions or other countries to be content to rely on us for the material essential for their defence. Nor is it to be expected that for the carrying on of civilised life in their own country they should consent to be mainly dependent on some outside country. They would only tolerate such dependence to the extent necessitated by the natural conditions and limitations of their own country. It is no use shutting our eyes to these facts. What is the lesson? It is that our engineering industry, and I am almost afraid of becoming tiresome in pointing it out, cannot afford merely to produce the bread-and-butter materials of engineering which almost any country can produce for itself. See what Japan has done in ninety years. It is an astounding development. The same thing is happening in Russia. We are helping her to become self-sufficing. The process goes on apace. We are a great engineering nation and we have a people, who, by reason of many generations of heredity, have acquired many skilled aptitudes for engineering. What is the use of fiddling away at the production of stuff to sell at £90 a ton when we imported in 1934 over £10 million of machinery valued at £200 a ton? What is the use of that? It is for us to make the highly refined and difficult products of engineering industry. It will take many years for other nations to reach that stage of engineering when they could compete with us in those products. Moreover, it is not an economic proposition for many of them to produce this class of products for their own small markets.

We have not only our home market, which is a much bigger one than the Dominions, but, by reason of our special ability, we have the power to build up an export trade in these highly developed products. That is the game for us to play. By getting a sufficient volume of production we can get prices down to a competitive level. But you cannot do that while you have much redundant capacity, one firm being satisfied if it can get back one-half of its general charges and another a quarter. You are not in engineering for that. At the present time the quantities of highly developed and specialised machinery imported into this country are a disgrace to the engineering industry. Here am I with the task of shortly having to approach the Government for an increase of duties on certain classes of machinery. What will I be met with? They will say, "You know the figures as well as we do. You are asking us to protect an industry which has not had the gumption or enterprise or ability to develop the manufacture of these highly specialised machines ranging from £170 to £500 a ton. You have to import these. When you start to make these machines and help to improve conditions at home then you can come to us." That is what they will say. I am in a very difficult position.

To come now to constructive proposals. Perhaps a little is accomplished by my talking here to-day, and if the Press support us that will carry us a little further. But nothing that really matters can be done until the great engineering leaders get together in conference and face the position and determine to study it and devise ways and means of carrying out those changes in our industry which are the essential complement to the other world changes in the institution of which we have no word and little influence. They are imposed by world conditions. What complementary conditions and changes should we make to meet them? Get together in serious conference. It is useless and a waste of time for boards solemnly to discuss merely whether they shall send £25 to the B.E.A. That is not engineering or industrial statesmanship. They must get together with us and tackle these questions seriously. With all the conviction I possess I say that unless these changes are made to bring it into conformity with world changes, then our engineering industry is going to decay.

A New Boiler for the Leicester Power Station.

A NEW boiler being erected by International Combustion, Ltd., in the Freeman's Meadow generating station at Leicester completes the equipment to be installed in the boiler-house, previously containing three powdered fuel-fired boilers supplied five years ago by the same firm. The new Lopulco single-pass unit is capable of a normal evaporation of 120,000 lb. per hour, a maximum continuous evaporation of 180,000 lb. per hour, and a peak load of 200,000 lb. for two hours. The steam pressure is 360 lb. per square inch and the total temperature at the superheater outlet 800 deg. Fah. All the drums are solid forged with riveted in ends, the front drum being 4ft. 6in. in diameter. The combustion chamber is enclosed by bare tubes closely pitched with a water screen, which is also composed of bare tubes. In the combustion chamber the tube thickness is No. 6 gauge, whilst that of the other tubes is No. 7 gauge, all the tubes being cold drawn.

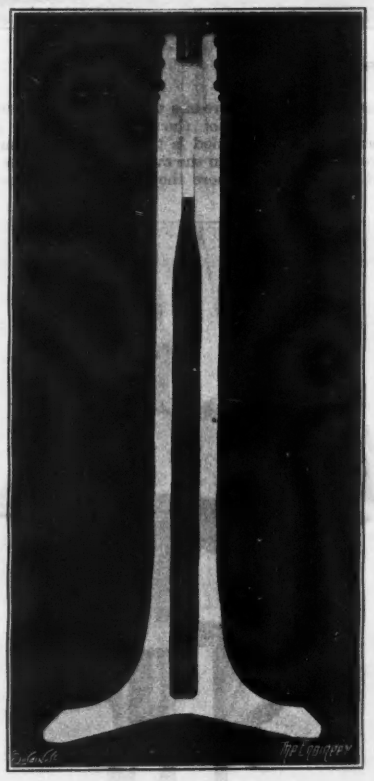
Two burners in each corner of the boiler are supplied with powdered fuel carried by primary air from feeders under a storage bunker supplied by a 15-ton Reymond milling equipment on a bin and feeder system. Together with the previous mills the extension enables the mills to supply the powdered fuel bunkers of any boiler by a system of screw conveyors. During grinding the coal is to be dried in the mills by hot flue gases, the ventage being taken to the combustion chamber. A M.L.S. inter-deck superheater capable of raising the steam temperature to 800 deg. Fah. on maximum continuous load is to be fitted. The feed water will be supplied at a temperature of 300 deg. Fah. through a gilled tube steaming economiser having a heating surface of 15,456 square feet.

Ljungstrom air heating equipment consisting of two units in parallel with a total heating surface of 39,500 square feet will reduce the final gas temperature to 280 deg. Fah. on maximum continuous load and will increase the air temperature from 70 deg. to 412 deg. Fah for supplying the burners.

An induced double inlet Howden fan with a cast iron casing is being provided for each section of the air heater. Two forced draught Howden fans are also being installed and will be driven by commutator motors controlled by Allen-West automatic combustion control apparatus. The primary air double inlet fan will take its supply from the secondary air ducts to the burners. Ivor soot blowers operated with superheated steam are being fitted to clean the various sections of the boiler. On leaving the induced draught fan the gases will be delivered to a "D" type dust collector discharging into a 200ft. stack common to an adjacent boiler. The ash deposited in the hopper below the combustion chamber will be intermittently discharged into an existing ash sluice and conveyed to a sump outside the boiler-house.

Sodium-Cooled Valves.

IN last week's issue under the heading "Aeronautics in 1934" we referred to the work which the Bristol Aeroplane Company Ltd. has been doing on the use of sodium for the cooling of aero engine exhaust valves. By courtesy of the company we are enabled to illustrate herewith a section of a typical sodium-cooled valve. It may be recalled that following the introduction of highly



SECTIONED SODIUM-COOLED VALVE

leaded fuels various schemes were tried for reducing the temperature of the exhaust valves by increasing the thermal conductivity of their stems. The most satisfactory results were obtained by hollowing the stems and filling them with metallic sodium which becomes liquid at the working temperature. A valve so made not only shows increased conductivity and a lower temperature but is lighter than a solid valve. In some cases an increased reduction of temperature is secured by making the head as well as the stem hollow. The patents covering the use of coolants which are liquid at operating temperatures are held by Mr. S. D. Heron and the Wilcox Rich Corporation of America, the sole rights in this country being held by the Bristol Company.

The Rectophot.

WE recently witnessed a demonstration of a new type of apparatus for making photo copies of drawings, designs, documents, &c., in fact, anything readable, which is being put on the market by S. Bornett and Co., Ltd., of 7, Idol-lane, London, E.C.3. It gives a true-to-scale copy in black and white, and although it does not involve any new radical ideas, is made in a very convenient form

The whole of the printing apparatus is contained in a case about the size of a large suitcase. In the bottom of this case there are arranged two or more strip-light type electric lamps, which are overrun so as to produce light as actinic as possible. Above the lamps there is a light filter and finally an opalescent glass plate. The document to be copied is placed on the glass with a sheet of sensitised Rectophot paper and the lid of the case closed. A resilient pad then presses the papers into intimate contact. In the lamp circuit there is a time switch, which may be set to give any desired exposure, while there is a receptacle at the end of the case for a roll of sensitised paper.

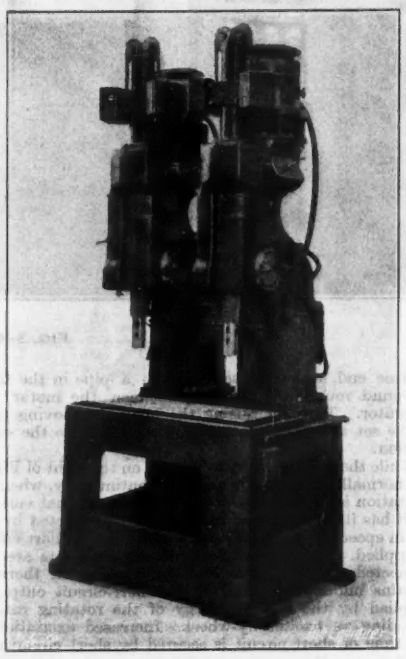
Only a few seconds' exposure is necessary, but a trial exposure may be needed and the switch reset according to the result. It is then necessary to develop and fix the print in special solutions, but the whole operation takes only about two minutes. The copy can be white lines on a black ground or *vice versâ*. Copies of opaque subjects, such as books, can also be made.

The apparatus is made in two models, one for prints up to 13½in. by 10in. and the other 22in. by 15in.

Two New Machine Tools.

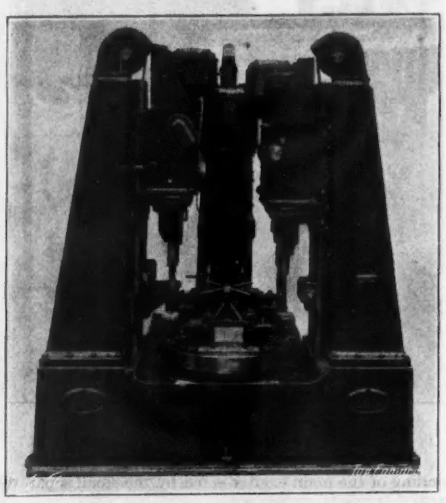
Two new machine tools by Kitchen and Wade, Ltd., of Arundel-street, Halifax, are shown in the accompanying engravings.

The first is a duplex tapping machine for tapping unions, junction-boxes, and other fittings. The head on the left is intended for taps from ¼in. to 1¼in. B.S.F.



DUPLEX TAPPING MACHINE

threads, and that on the right for taps from 1¼in. to 2in. The machine is entirely automatic and continuous in operation, and its cycles are so timed as to allow the attendant to unload and reload the work pieces while the spindles are in the top positions, the pieces being held in quick-loading fixtures. These fixtures are, of course, designed to suit the work in hand, and are not shown in the engraving. The spindles have definite tapping leads, which are changed to correspond with the thread being tapped by pick-off gears. They are reversed electrically at double



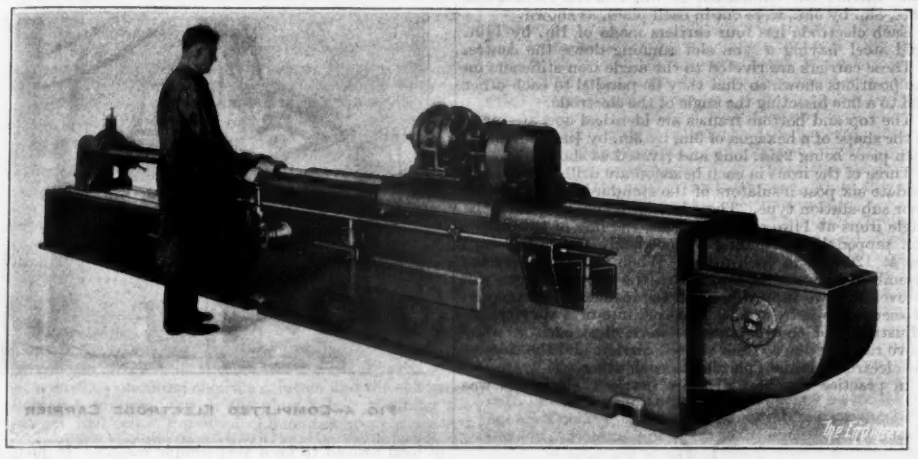
TRIPLE HEAD AUTOMATIC

the cutting speed. The driving gears run in oil and the final drive to the six-splined spindle is through hard steel and phosphor bronze gears. The weight of the machine is 33 cwt.

The second machine is a triple-head automatic with six spindles intended primarily for machining aeroplane engine connecting-rods. The rotary work table has four positions, so that the operator can load and unload it while the tools are at work and get a continuous output. The first head drills the two holes in the rod, the second point tools out the bores, and the third reams them. All three operations are, of course, carried on simultaneously, and are controlled electrically. The weight of the machine is approximately 6½ tons.

A Large Honing Machine.

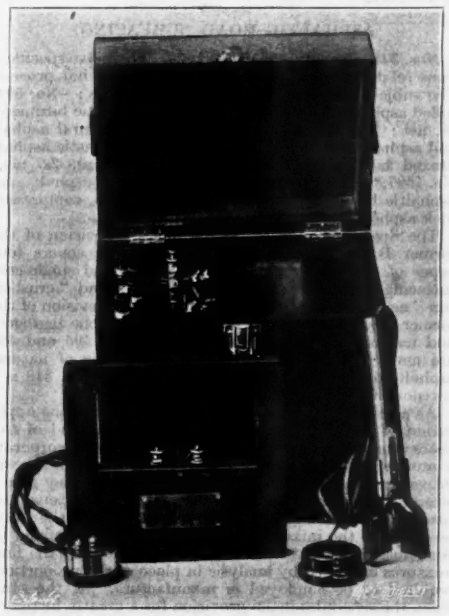
THE illustration which we reproduce below represents an unusual form of honing machine, made for the Nanking Arsenal, in China, by the Barnes Drill Company, of America, whose London agents are Gaston E. Marbaix, Ltd., of Vincent House, Westminster. It is intended for honing the interior bore of long objects, such as recoil cylinders, periscope tubes, &c., and has consequently been designed with the work piece arranged in a horizontal direction. The length of stroke is 6ft. and the machine will hone bores up to 5in. in diameter. The honing head slides on hardened steel bar tracks and is reciprocated by an hydraulic motor driving cables running over pulleys in the housing seen in the foreground. This motor is, in turn, supplied with power by an electrically driven pump at the back of the machine. Arrangements are provided so that the honing head can be reciprocated over a short stroke, should it be necessary to work down a local hard spot. The whole of the operations are controlled by the one lever seen at the operator's station.



LARGE HONING MACHINE FOR LONG BORES

A Cable Tracer and Fault Locator

THE cable tracer and fault locater, shown in the accompanying illustrations, has been brought to our notice by Price and Belsham, Ltd., of Tamworth-lane Works, Mitcham, Surrey. It is capable of identifying one cable from another, even if they are close together, traces the route, and indicates the depth of a cable after street alterations have removed the landmarks, and under certain conditions it provides a convenient means of locating earth faults and short circuits. An impulse generator and its battery are enclosed in the case shown in the first illustration. The remaining equipment consists of search coils, one large or small square coil, and one in the form of a horseshoe, both provided with leads and a telephone receiver. While the square type of coil is more sensitive than the horseshoe coil, the latter is more selective, because it is less liable to interference from neighbouring magnetic fields, but until experience has been gained in operating the apparatus it is advisable to try both coils to ascertain which gives the best results. The square coil is totally enclosed in a wooden frame with a case containing a condenser and telephone terminals. The horseshoe magnet coil is former wound on a core. It is protected and bakelised, and there is a condenser in the short handle. A key associated with the generator is useful for detecting small currents.

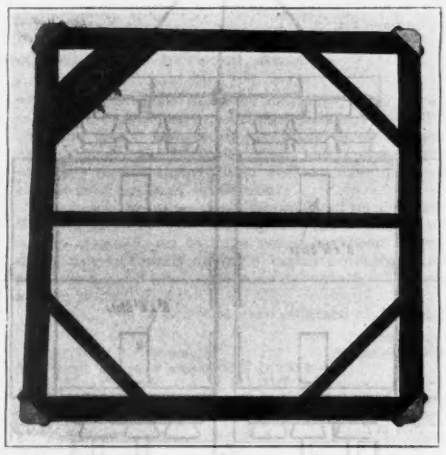


GENERATOR AND SEARCH COILS

When the apparatus is used for locating faults the generator is connected to the conductor so as to cause the pulsating current from it to traverse the conductor and escape at the fault. The position of the fault is found with the aid of the search coil and telephone receiver, in which the noise is naturally reduced when the fault is passed. When using the apparatus with the large search coil for tracing an earth fault on buried cables or overhead lines one of the generator terminals is connected to the faulty conductor and the other to earth, when the tester follows the line of the cable with the search coil and notes the sound as he proceeds. With an overhead line or V.B. cable with a sheathing of insulating material the indication of the fault is sharp and clear; in other words, the sound suddenly ceases when the fault is passed, and almost the same effect is said to be obtained when a lead-covered and armoured cable is buried in damp conductive soil. But when a cable of the latter type is laid in dry earth the current escaping at the fault then usually runs both ways along the lead, with the result that the sound in the telephone falls off over a distance of several yards.

The fault is usually found, however, at about the middle of the "fall" and slightly towards the louder end. Owing to the current in the conductor inducing current in the lead sheath, sound is often met with all the way along the cable, but as it forms something in the nature of a background upon which the sound being sought is interposed, an experienced tester is able to ignore it.

When a fault is on a branch service the sound due to the induced current is heard along the main on both sides of the "tee," but just over it there is a point of dead silence at which the original and induced currents neutralise each other. In difficult cases in which the sound at the fault is small it is often desirable for the tester to walk towards the generator so that the sound presents itself as an increase instead of a decrease, and it is also advisable in some cases to check the test with the generator at the opposite end of the cable to that at which it was originally placed.



LARGE SEARCH COIL

When locating short circuits the two generator terminals are connected to the conductors affected. If the conductors are in the form of two separate cables it is then a simple matter to trace the current along one cable to the point of short circuit and then back again along the other cable. In the case of a short circuit without an earth in a concentric or multicore cable the test may be more difficult, but by no means impossible, as neither of these cables is entirely non-inductive. While little or no sound may be heard when walking from the generator to the fault, a strong sound may be detected beyond the fault, thus giving a clear indication of the fault position. Generally, however, a "short" is accompanied by an earth, and it is then desirable to treat it as an earth fault.

Dead ends and "burn-outs" can usually be located without difficulty by connecting up the apparatus as when testing for an earth fault, for, since the conductor and earth form a condenser, the current is able to flow up to the dead end or the point at which the cable is severed. After experience, cable testers generally find that they can locate faults while a cable is alive, but in this case it is essential to connect a "safety box" containing a condenser and fuse between the generator and live main. For obvious reasons the strength of signals is approximately inversely proportional to the square of the depth of a cable. If the cable depth varies, as, for example, at a road crossing, the falling off of signals may be mistaken for the indication of the fault, whilst, on the other hand, the reduction in strength at a road crossing may be disregarded on the incorrect assumption that the cable depth has increased, when, as a matter of fact, it has not. To prevent such mistakes the tester finds the cable depth a yard or so before and after the fall in sound by laying the coil flat on the ground and by moving it over the cable line until silence is obtained, when the centre of the coil will be over the cable. A depth indicator is next fixed to the coil, which is then placed 4ft. 6in. to one side of the cable and tilted over slightly towards the cable until silence is again obtained, when the pointer will indicate the depth in feet.

As a check this test may be repeated on the other side of the cable. If the depth indicated on the side on which the sound is least is greater by, say, 6in. or more than it is on the louder side, the drop is in all probability due to increased depth, whilst if the depth indicated on each side is the same, the drop may be taken as an indication of a fault.

An Hydraulic Tower Wagon.

A NEW form of extendable tower for giving access to overhead wires, lighting lamps, and so forth, which is being made by the Wood Hydraulic Hoist Company, Ltd., of Southport, is shown in the accompanying engravings. It is operated hydraulically and can be mounted on any 2–3-ton chassis.

As shown, the chassis can also carry a van body, which may be used for spare parts, tools, or as a travelling workshop. The ram which carries the platform is operated by a rotary pump driven by a take-off gear from the change-speed gear-box of the van. It can be controlled either from the platform itself or from the cab, and rises to a full height of 30ft. In the lowered position the platform is 11ft. 6in. from the ground, and is then accessible by a short ladder at the back of the van. The workmen are then, of course, raised by the ram on the platform. It takes only 40 seconds to get up to the full height. The platform is highly insulated, and can be locked in any position, while it is quite rigid and level, whether it is set fore and aft or athwart the chassis. It also has the great merit of saving much time over that usual with hand-operated towers.

HYDRAULIC TOWER WAGON

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

FINANCE AND INDIVIDUALISM.

SIR,—In your Leader of November 9th appear the words: "Industrialists as a whole are by nature opposed to anything that restricts their individual activities."

It will be well, then, if industrialists searchingly examine the financial system under which they work, not so much to admire the marvellous bookkeeping ramifications, as to peer into the reasons for its assumptions of power.

A friend of mine heard the redoubtable Sir Josiah Stamp admit to an audience at Cambridge that (as he saw it) freedom in industry had gone for ever! We endure the virtual dictatorship of a system with policies which are haphazard, pagan, and silly.

Mathematical formulæ and statistical methods must be substituted for the present hotchpotch of expedients. The marketing of money must vanish. Finance should not be so much an entity as a reflection of an unrestricted commodity market, and the power to create credit should revert to the Crown. Some form of consumer credit is a stark necessity in a mechanised age, otherwise there is a chronic shortage of purchasing power.

Let all producers and/or consumers rally around Major Douglas and regain our freedom.

C. H. ALLEN, A.M.I.E. (Aust.).

Ashleigh Grove, Unley Park, Australia,
December 14th, 1934.

A Liquid Resistance for 4200 kW.

By H. P. BRACE.

THE particular purpose for which this apparatus was designed was the testing of a 6000 h.p. water turbine coupled to a 5600-kVA at 0·75 power factor three-phase 6600-volt alternator. The tests carried out were those specified in the standard Test Code for Hydraulic Power Plants for Machines after completion of erection on site, acceptance of the machine by customer depending on the test results comparing favourably with the manufacturer's guarantee.

Such tests are not often carried out in their entirety, because the facilities on site do not lend themselves very readily to the required conditions, and, more often than not, the most difficult feature to obtain is the desired load condition. It may be impossible, or at least difficult, to obtain steady commercial loads of the required dimensions, and the throwing on, and off, of full load may cause a serious disturbance of the system which would not be tolerated by many undertakings.

To carry out such tests then it is essential to have some form of artificial load entirely separate from the station

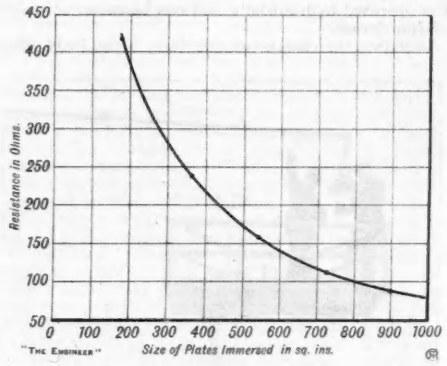


FIG. 1—EFFECT OF PLATE IMMERSION ON RESISTANCE

load, and the advantages of such an arrangement greatly outweigh the additional expense involved and the trouble of making it up.

The new plant can be thoroughly proved before being put on commercial load, and, if necessary, adjustments and modifications can be carried out with facility without jeopardising the supply system.

The artificial load apparatus must, however, be of such a robust design that there must be no possible risk of damaging the machine by faulty construction or mal-operation. It must be installed so that it can be used with safety and confidence by the station operatives, who may be quite unfamiliar with the precautions observed in the test departments of the larger electrical manufacturers, where such tests are common enough. It must be conveniently adjustable and yet rigid enough to prevent distortion due to magnetic influences or changes of temperature.

The most suitable type of artificial load for this purpose is undoubtedly the water resistance, as there is usually no difficulty in arranging an adequate water supply in a power-

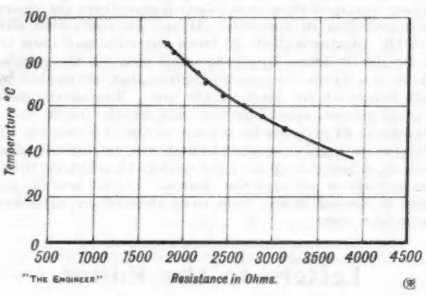


FIG. 2—EFFECT OF TEMPERATURE ON RESISTANCE

house. In the case of a hydro-electric plant the tail-race offers an ideal supply and it is only necessary to build a suitable tank and provide a means of adjusting the amount of cooling water required.

To arrive at the size of electrodes and the distance between electrodes various tests were made with the water to be used.

(1) Two rectangular sheet iron plates were fixed rigidly parallel to each other in a wooden frame and suspended in a tank of the water, the plates being graduated to show the amount immersed at a glance. The resistance between the two plates was measured for various areas immersed and at various spacing between electrodes. The results are shown in Fig. 1.

(2) A graph was made—Fig. 2—showing the difference in resistance between two small discs in the water as the water temperature was increased to boiling point.

Two discs of 1¾in. diameter were used and placed 2¼in. apart. It may be mentioned that the water actually tested contained a considerable amount of silt from tin mine workings.

The formation of the electrodes as shown in Fig. 3 was adopted, as this appears to be the most convenient, from a construction point of view, and it certainly proved to be easy to construct and, in addition, had the features required, namely, (1) rigidity, (2) ease of adjustment, (3) ease of operation, and (4) safety.

The construction is shown in Figs. 3 and 4, from which it will be seen that the electrodes are formed by three rectangular pieces of sheet iron, 6ft. by 3ft. by $\frac{5}{16}$in. They are bent to form an angle of 120 deg. and stiffened by 3in. by 3in. by ¼in. angle iron being riveted to the long edges. Gusset plates are also riveted to the angles to maintain the correct angle, and the two short edges of each plate are bent back to give the plate rigidity and facilitate the circulation of water between the electrodes. To promote further the circulation of water seven rectangular slots, 8in. by 5in., were cut in each plate, as shown.

Each electrode has four carriers made of 1in. by 1¼in. mild steel having a $\frac{5}{16}$in. slot running down the centre.

These carriers are riveted to the angle iron stiffeners on the positions shown so that they lie parallel to each other and to a line bisecting the angle of the electrode.

The top and bottom frames are identical and are made in the shape of a hexagon of 3in. by 3in. by ¼in. angle iron, each piece being 24in. long and riveted as shown.

Three of the irons in each hexagon are drilled to accommodate six post insulators of the standard 6600-volt outdoor sub-station type. These insulators are placed on the angle irons at 14in. centres so that the line of two of the ½in. tapped holes running diametrically across the caps are at 120 deg. to each other. When the electrodes are assembled between the two frames the slotted carriers will fit over the two tapped holes in the insulator cap and can be secured to it by studs. This permits of a very simple adjustment of the distance between electrodes, as they move radially due to their slotted carriers and the sides of the electrodes remain parallel to each other.

In practice the best distance between electrodes was

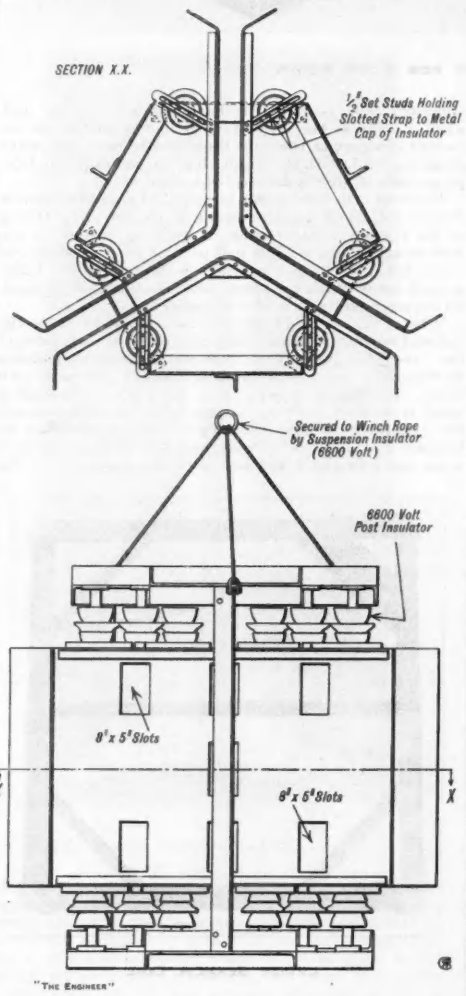

SECTION X.X.
½" Set Studs Holding Slotted Strap to Metal Cap of Insulator
Secured to Winch Rope by Suspension Insulator (6600 Volt)
6600 Volt Post Insulator
8" x 5" Slots
8" x 5" Slots
Y
X
"The Engineer"

FIG. 3—CONSTRUCTION OF ELECTRODE CARRIER

found to be 5in., as this gave the full range of load required and no trouble was experienced due to flashing.

This setting gave the following resistances between phases, and the balance was very close :—

Depth of electrodes immersed. Inches.	Resistance. Ohms.
6	142
12	88
18	64
24	52
30	44
36	38·5

Full load, 4200 kW, was obtained with the electrodes immersed 34in., it being merely a question of regulating the amount of cooling water to prevent the water between the electrodes boiling too fiercely.

With a tank measuring 8ft. by 8ft. by 5ft. deep a load of 4200 kW could be maintained indefinitely and with 200 gallons of water flowing the temperature rose from 22 deg. Cent. to 38 deg. Cent. Inlet water was admitted at the bottom of the tank and deflected to the centre of the rheostat and discharged over a weir.

It will be obvious that where shortage of water is a factor to be dealt with the amount required could be considerably reduced by allowing the water to discharge on all sides of the top of the tank and arranging the inlet water to enter directly under the centre of the load.

The electrode carrier was suspended over the tank on a wooden frame and raised and lowered by means of a small worm-driven hand winch. The load was insulated from the winch by a suspension type insulator. The neutral was connected to an iron plate lying in the bottom of the tank and solidly earthed.

Three V.I.R. cables of the required capacity were led to each electrode from the frame above, the cables hanging in a bight. Three small cables were used because they gave much more flexibility than one large one. The operator controlling the winch carried a portable telephone in communication with the switchboard and the regulation

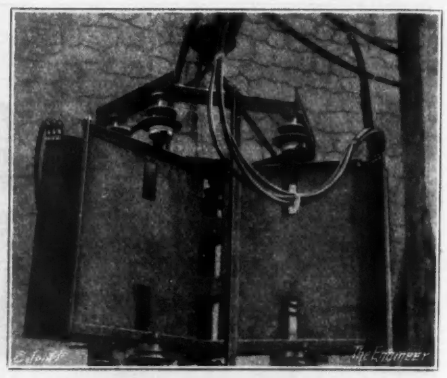


FIG. 4—COMPLETED ELECTRODE CARRIER

of load proved to be a very simple matter. In fact, the whole arrangement worked admirably and no difficulty of any kind was experienced.

Consumption tests of the new plant were taken and the throwing on and off of various loads from no load to full load, for the purpose of checking governor operation and pipe line surge effects, were carried out.

A Tirrill voltage regulator was connected to the set so that, in order to check the behaviour of the machine on changes of load, it was only necessary to manipulate the hand winch to give the required load change, constant voltage being maintained by the regulator.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

ASPHALTIC ROAD SURFACING.

Nos. 348, 594, 595, 596, 597—1935. These five specifications relate to asphalt road surfacing by the hot process. The subject matters and prices are as follows :—No. 594, rolled asphalt (fluxed lake asphalt and asphaltic bitumen), 5s. net ; No. 595, rolled asphalt (fluxed natural asphalt and asphaltic bitumen), 5s. net ; No. 596, Mastic asphalt (fluxed lake asphalt and asphaltic bitumen), 2s. net ; No. 597, mastic asphalt (fluxed natural asphalt and asphaltic bitumen), 2s. net ; No. 348—1935, compressed rock asphalt.

The Specification No. 594 comprises a revision of the former B.S.S. Nos. 342 to 345—1928. It covers four types of construction, namely, two-coat and single-coat surfacing with sand and stone aggregates and "crusher-run" aggregates respectively. No. 596 is a revision of the former B.S.S. No. 346, and covers both limestone aggregate and natural rock asphalt aggregate. Nos. 595 and 597 are new. They make provision for the use of natural asphalts other than lake and rock asphalt. No. 348 is a revision of the 1928 issue.

As a result of the experience gained through the application of the former specifications over a period of five years it has been possible for the Institution to incorporate a number of improvements, and the new standards will provide a more specific basis for tendering. They give a clearer indication as to the suitability of the various mixtures for prevailing local conditions, whilst the compositions of the mixtures are more specifically defined by the substitution of schedules of compositions of the final mixtures as shown by analysis in place of the proportions required to be employed in manufacture. At the same time, the schedules make provision for a greatly increased range of mixtures to be available to the engineer.

The Specifications Nos. 595 and 597 have been prepared to make provision for the use of natural asphalts which were not covered formerly by the B.S. Specifications Nos. 342 to 348. The specifications cover the same field of road construction as the B.S.S. Nos. 594 and 596, but include a different schedule of properties for the asphaltic cement, and provide for the somewhat different method of manufacture which is necessitated by the properties of these particular natural asphalts.

In all of these specifications the nature of the construction dealt with, the gradings of the aggregate, and the proportions of asphaltic cement have been the subject of the most careful consideration in the light of present-day knowledge, and are such as to provide surfaces of non-skid type.

We are informed that the Institution is on the point of issuing Standard Methods for the Sampling and Examination of Bituminous Road Mixtures. These methods lay down the procedure to be followed for the verification of road mixtures made both in conformity with the foregoing asphalt specifications and also with tarmacadam. The specification will have the reference number No. 598.

The E.M.F. Between Metals in Seawater.*

By J. W. WILLSTROP, B.Sc., A.I.C.

IF two dissimilar metals immersed in sea water are connected either by actual contact with each other or by a third conducting material, there will be a flow of current from one metal to the other, and this will be accompanied by solution or corrosion of the negative metal. This corrosion is not to be confused with any corrosion the metals might suffer independently as a result of sea water attack.

The tendency for this electrolytic corrosion to occur is dependent on the E.M.F. or potential difference between the metals when immersed in sea water.

The possibility of serious corrosion arising from this cause in the case of widely differing metals used in aircraft, particularly marine aircraft, led to the investigation of potential differences occurring between various metals normally used in aircraft construction.

Method of Determining E.M.F. between Metals.—In early experiments an attempt was made to measure the potential difference between various metals directly but inconsistent values were obtained, due to variation with time of immersion of the potential of one or both of the metals. Consequently, it was decided to use an invariable standard against which the potential of each metal could be measured and the actual E.M.F. between any two metals was then given by the difference of their respective potentials against the standard. The standard chosen was the normal calomel half-cell. This consists essentially of an electrode of mercury in contact with a normal solution of potassium chloride containing mercurous chloride in suspension. Electrical contact was made between the potassium chloride solution and the sea water through a ground joint in the glass tube containing the calomel half-cell. Potential differences were measured between the mercury and various metals immersed in the sea water bath.

The potentiometer used was of the type employing a thermionic valve. This instrument enabled the potential differences to be measured without the possibility of any current flow which would cause polarisation of the metals and render the potential readings inaccurate. The arrangement is shown in the diagram.

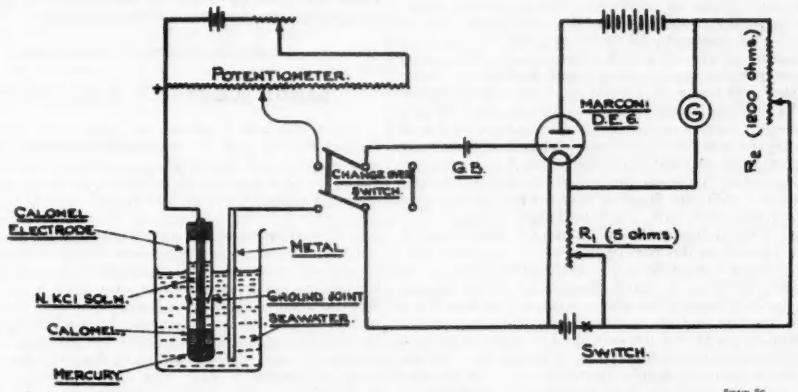


DIAGRAM OF CIRCUIT FOR DETERMINING E.M.F. BETWEEN METALS

A galvanometer G was put in the plate circuit of an ordinary thermionic valve. By making use of the drop in potential across the filament rheostat R_1, a small current, adjustable by R_2, was obtained in the galvanometer in the reverse direction to that of the plate current. By this means the current in the galvanometer could be reduced to a very small value, thereby allowing a more sensitive instrument to be used than would otherwise have been possible. A biassing battery (G.B.) of 1½ volts was used to ensure the grid remaining negative over a fairly wide range.

In using the instrument the rheostat R_2 was adjusted to bring the needle of the galvanometer G somewhere near the middle of the scale, the change-over switch, of course, being in the right-hand position. The potentiometer was then adjusted until there was no change in the galvanometer reading when the switch was pushed over to the left-hand position. The potential between the calomel electrode and the metal was then exactly balanced by the potentiometer, and was therefore given by the reading of the latter.

The sea water used in these tests was kept at a temperature of 25 deg. Cent. by means of a thermostat and readings of E.M.F. between the calomel electrode and metals immersed in the sea water were taken at various intervals after immersion. The sea water was not stirred.

Results of Experiments.—The results obtained are given in detail in the following tables. In all cases the potential of the metal under test was negative to that of the calomel electrode. Hence in comparing the potentials of any two metals, the metal giving the higher value of the two will be negative to the other, and will tend to corrode in the event of electrical contact being made between the two metals while they are exposed to the influence of a corroding agent. For example, contact between D.T.D. 57 steel (potential 0·20 volt) and duralumin (potential 0·65 volt) will result in corrosion of the duralumin. Expressed differently, a battery is formed by these two metals and the sea water, having an initial voltage of 0·45 volt and the resulting current flowing when the metals are connected will be accompanied by corrosion of the duralumin. It may be mentioned here that this flow of current will produce an opposing potential (polarisation), which has the effect of reducing the corroding current considerably though not to a negligible value. The corroding current will also be affected by the degree of aeration of the sea water and by any resistance introduced into the system by oxide films or coatings of paint or varnish.

Nevertheless, the potential difference between two metals may be taken as a rough measure of the tendency of the more negative one to corrode through electrolytic action when the metals are connected.

With some alloys, particularly stainless steels of the 18 : 8 type, a steady potential is not attained, even after long immersion, and the observed potentials seem to fluctuate about a value of about 0·20 volt. This may be due to periodic changes in passivity. In the case of duralumin it was noticed that samples tested six days after heat treatment took many hours to attain a steady potential, though after ageing for a further seven days a constant potential was reached after about one hour.

A remarkable value was given by a sample of cold rolled D.T.D. 60A having a chromium content of 15·7 per cent. This was so different from the results obtained with other steels of this type that it was decided to make a practical test. A piece of this steel and a piece of cold-rolled D.T.D. 60A, containing 18·3 per cent. chromium were immersed in sea water and kept in contact by means of a clip above the water line. After two days definite corrosion of the former had occurred, while the surface of the latter remained clean after two weeks.

Similar experiments were also made with Alclad and duralumin against D.T.D. 57A. Alclad and duralumin showed practically no corrosion after six days' immersion in sea water with D.T.D. 57A, provided that the metals were not in contact. It was observed, however, that a piece of Alclad, duralumin, or anodised duralumin when in contact with D.T.D. 57A showed definite signs of corrosion after one day's immersion. Anodised duralumin appeared to be no better than untreated duralumin in this respect, probably due to the fact that when saturated with sea water the anodic film has a low electrical resistance. Coating the Alclad or duralumin with adherent films of "Heldite" or of standard undercoating and V. 85 would be expected to reduce the corrosion current passing between the samples and the pieces of D.T.D 57A, and to reduce the rate of corrosion appreciably.

In the case of magnesium alloys the effect of contact with stainless steels was very marked. When connected to D.T.D. 57A in sea water a piece of 14 gauge D.T.D. 88 corroded away completely in three days. When not connected to the stainless steel the magnesium alloy merely suffered rather deep etching over part of the surface after six days' immersion.

The following table gives a summary of results obtained. Where a constant potential against the calomel electrode is not attained, an average value has been given. As stated above, metals having a higher potential value are negative to, and tend to corrode in contact with metals of a lower potential.

Values given in brackets were obtained at 40 deg. Cent.

Metal.	Potential against calomel electrode.
Austenitic stainless steels, D.T.D. 57A and B, D.T.D. 166, D.T.D. 171, D.T.D. 428, D.D.Q.	0·15–0·25 volt (0·20)
Monel metal	0·18 volt (0.18)
Gun metal, B.2	0·21 volt
Aluminium bronze	0·26 volt
Brass, 3.B.12	0·27 volt
Twoscore stainless steels, S.80, D.T.D. 60A	0·30–0·40 volt (0·33)
D.T.D. 105	0·45 volt
D.T.D. 46A	0·58 volt
D.T.D. 54A	0·62 volt
Duralumin, heat-treated and aged (or cold worked)	0·65 volt (0·78)
Duralumin Z.B.	0·69 volt
S.65	0·71 volt
Duralumin, softened	0·72 volt
S.4, D.T.D. 138	0·72 volt
Royce-Royce alloy sheet	0·73 volt
S.2	0·73 volt
Duralumin plat.	0·76 volt
S.6, S.21	0·76 volt
D.T.D. 12	0·79 volt
D.T.D. 25	0·81 volt
M.G. 7 alloy	0·81 volt
Birmabright	0·82 volt
Aluminium	0·82 volt (0·90)
Cadmium (plating)	0·82 volt
Zinc (plating)	1·13 volt
Magnesium alloy (D.T.D. 88)	1·59 volt

Further Tests on D.T.D. 60A Steel.—In view of the difference in behaviour of various samples of D.T.D. 60A steel when tested, further samples of this type of steel were examined in order to obtain information on the factors governing potential in sea water. At present the data available are insufficient to explain the variation completely, though it may be stated here that high values in the neighbourhood of 0·60 volt have so far only been obtained from steels containing about 16 per cent. Cr. Those containing 18 per cent. Cr irrespective of treatment have given considerably lower values than this.

* Communicated to the Aeronautical Research Committee by the Director of Scientific Research, Air Ministry.

Prophets and Panaceas.*

By DEXTER S. KIMBALL, Dean, College of Engineering, Cornell University.

MAN, in his long journey from savagery to civilisation, has never lacked for prophets and seers who could see, or pretended to see, what the future held for him. Every age has had its Jeremiahs, Ezekiels, and Isaiahs, and these have always been particularly vocal in times of depressions such as this, from the very beginning of the modern industrial era. Mr. Bancroft Gherardi, in a booklet called "Engineers and Progress," published in January, 1933, has collected some of these prophesies. I quote very briefly from these more extended jeremiads.

Macaulay, the British essayist, writing in 1830, says: "The present moment is one of great distress. . . . We cannot absolutely prove that those are in error who tell us that Society has reached the turning point—that we have seen our best days. But so said all who came before us with just as much apparent reason."

Again, in New Haven, Conn., in 1837, another writer remarks: "Already want like an armed man stands at the threshold of many a dwelling where a few days ago daily industry brought the supply of daily comforts. Amid these present calamities and these portentous omens of the future it is not strange that many minds are seeking and all voices debating the cause and the remedy." Once more in 1857, in *Harper's Magazine*, we read: "It is a solemn moment and no man can feel an indifference in the issue of events. Of our own troubles no man can see the end." And again in 1886, or forty-eight years ago, Carroll D. Wright, Commissioner of Labour, writes in his first report: "This full supply of economic tools to meet the wants of nearly all branches of commerce and industry is the most important factor in the present industrial depression. It is true that the discovery of new processes of manufacture will undoubtedly continue and this will act as an ameliorating influence, but it will not leave room for a marked extension such as has been witnessed in the last fifty years, or afford a remunerative employment of the vast amount of capital which has been created during that period. The market price of products will continue low no matter what the cost of production may be. The day of large profits is probably past. There may be room for further intensive, but not extensive, development of industry in the present area of civilisation." And so one could go on without end.

The great trouble with these prophets of despair is that they never have all the factors in the situation. The greatest and best illustration of this is found in the prophecy of Dr. Robert Malthus (1766–1834), a professor of Cambridge University. Malthus proved to his own satisfaction that the human race, if unrestricted, increased in the geometric ratio 1, 2, 4, 8, 16, 32, 64, 128, 256, doubling in numbers every twenty-five years. He stated that food supplies could be increased only in the arithmetic progression of 1, 2, 3, 4, 5, 6, 7, 8, 9. Thus in two centuries the ratio of population to food would be as 256 to 9 and in three centuries as 4096 to 13 and ultimately starvation must result. The "Malthusian theory," so called, was a most disturbing factor for many years and is still called to our attention, with the result that Malthus has come down to us as a prophet of despair rather than as the author of one of the best studies of population ever written. The difficulty with his theory lies in the dogmatic mathematical form in which it is stated. It is always unwise to extend a curve far beyond our present knowledge. Malthus could not see modern scientific agriculture, scientific canning and preserving, or modern transportation facilities which have made vast areas available for food supplies. It is doubtful if he fully appreciated the great industrial changes, taking place before his eyes, which were destined to enlarge man's idea of economic freedom.

It is against such a background that I have tried to view the present situation. Let me remark in the beginning that I hope nothing I shall say will be construed as destructive criticism of the New Deal, so called, for there are some features of it that I heartily approve. It will be remembered that we have had similar slogans in recent years. Theodore Roosevelt announced a "Square Deal," Woodrow Wilson inscribed the "New Freedom" on his banner, and no doubt some of the features of both were economically as debatable as any features of the New Deal. History repeats itself, but the race is very slow in learning the lessons that it teaches, and it is of some of these lessons that I shall speak.

HUMAN FREEDOM IS POLITICAL, RELIGIOUS, AND ECONOMIC.

Human freedom is of three degrees, political, religious, and economic, and the effort to attain some measure of such freedoms has been with man from the beginning and will follow him to the end. No large civilised nation has as yet been able to attain full freedom in all three degrees. The bloody story of man's effort to attain political and religious freedom with its awful toll of human lives needs no rehearsal here except to note how difficult it is to win such freedoms and how easy it is to lose them, as illustrated by the events in Russia and certain other European countries in the last few years. Political and religious freedom is enjoyed in only a very few lands to-day, and ours is one of them. Let us see to it that we do not lose it.

By economic freedom I mean freedom for all from poverty and all of its accursed results; freedom through the conquest of our material surroundings so that all men may live as men and not as beasts, and freedom to enjoy at least some of the finer things of life free from the haunting fear of unemployment, want, hunger, and the despair that has always been the lot of a large part of mankind.

So far as the great mass of humanity is concerned economic freedom has always been an idle dream and it was not until the advent of modern methods about 1800 that any hope whatever of universal well-being was offered to mankind. Any account of the growth of modern industrial and scientific methods has no place here, but it must suffice to state that by 1900, it is commonly agreed

* Seventh Henry Robinson Towne Lecture on Engineering and Economics. Delivered at the annual meeting, New York, N.Y., December 3rd to 7th, 1934, of the American Society of Mechanical Engineers.

that for the first time in the history of man he could produce food, clothes, shelter, in fact everything required by human wants in an abundance never before seen on this earth, and economic freedom was a possibility so far as the methods of production were concerned. The average well-being in this country in the early part of this century was probably the highest ever attained by any great civilised country, and what we might have done with this new power in times of peace we shall never know. The Great War with its disjointing effects, the tremendous expansion of our industrial equipment which resulted, and the false prosperity that followed, all came at a most inopportune time, and as we crawl out of the *debacle* of 1929 the world is filled with confused thought and innumerable panaceas for our relief and for the prevention of future depressions.

We are told that the world is basically changed and that never again can we hope to see anything like the good old times. We are told that we shall never again see an era like that of 1900–1914 unless we make radical changes in our political and social economy. Articles, pamphlets, and books in large numbers have been issued in recent months by engineers, professors, economists, lawyers, labour leaders, and others, offering explanations as to the causes of our troubles and panaceas for their cure and prevention. The Committee on the Balancing of Economic Forces appointed by the American Engineering Council recently reviewed and digested a large number of these efforts. These plans, coming as they do from intelligent men, present a baffling front. The single finding that the Committee was willing to present, drawn from this presentation of causes and remedies, is that no one all-inclusive cause can be designated as the forerunner of business recession. Nor can any one all-inclusive remedy be found as a preventive or cure. Our business and industrial structure is certainly complex.

Now, of course, the world is changing and has been changing rapidly ever since the Industrial Revolution. The new industrial and scientific methods have tended constantly to separate the worker farther and farther from the ownership of his tools, they have separated agriculture from the mechanic arts to the degree that what benefits one group may not help the other. These new methods have broken up old trades and have created many new callings and they have created more employment than they have destroyed. Without doubt they have made the world a much more complex place and the industrial machine to which we are all bound hand and foot is much more delicately balanced than it was and hence much more easily thrown out of adjustment. But in spite of these drawbacks, it should be remembered that these new methods are the only ones ever devised that are capable of giving us economic freedom. To say that we cannot control this industrial machine in the interests of all is to admit our mental inadequacy. It will not be easy to do, but I believe it can be done.

It should be remembered, moreover, that all advances, whether industrial, political, or religious, are, and always have been, accompanied by trouble and suffering. It appears to be inevitable that no great reform or betterment can be accomplished without suffering upon the part of many. Make no mistake in this matter. If we shall achieve economic freedom, a high standard of life, security and delight in work and leisure, as we have to some degree achieved political and religious freedom, it will be through much trouble and against no little opposition.

The several methods that are now being tried in Europe to cure modern industrial and social ills are worthy of more than a passing thought. We are not likely to adopt communistic methods in this country, though we may enlarge our ideas of government ownership as regards some common necessities. Nor are we likely to permit the development of any form of dictatorship. It should be remembered, however, that, as pointed out over two thousand years ago by Greek philosophers, the cycle of government is from a democracy to an oligarchy, from an oligarchy to a dictatorship, and through a violent upheaval from a dictatorship back to a democracy, and so on. A dictatorship might indeed solve some of our industrial problems, but a dictatorship, whether by a minority group or an individual, is always subversive of political freedom and usually subversive also of religious freedom. We shall do well to guard carefully the right to go to the polls periodically and change our rulers as we deem wise. Economic freedom at the expense of political and religious freedom would avail us very little. Who would have supposed that Germany would complete this cycle from dictator to dictator in the brief period of fourteen years?

Some Proposed Reforms in Social Economy.

Consider now, in the light of the foregoing, some of the proposed reforms in our social economy. We are told that we are seeing the passing of *laissez faire* or "rugged individualism," the inference being that the country is filled with industrial leaders who until now could do as they pleased. Such remarks display dense ignorance of the history of labour legislation during the past 100 years. As a matter of fact, *laissez faire* has never been anything more than an economic theory, in civilised lands at least, and while no doubt there are many compensating characteristics in modern industrial economics, no modern nation has been willing to trust them to guard, for instance, the welfare of the working classes. The greatest curb ever put upon rugged individualism was the anti-trust legislation of the latter part of the last century, and history abounds with illustrations of legislation by the majority to control the minority. A mere glance at the industrial legislation of our older industrial states will verify this statement. Experiments such as we are now trying are very ancient. The Code of Hammurabi promulgated about 4400 years ago fixes the rates of pay for doctors, veterinarians, and all kinds of artisans, and in many other ways regulates industry exactly as we are trying to do to-day. History does not tell us what success he had with his code. The Statute of Labourers enacted in England in 1349 and which, many times amended, was operative until the Industrial Revolution, originally fixed the minimum working day at twelve hours and otherwise legislated in favour of the employer rather than worker. Modern industrial legislation, beginning with the English Factory Act of 1812, has tended to regulate industry in favour of the worker, and the public and the N.I.R.A. simply extends the principle. In so far as it tends to eliminate abuses such as racketeering, unfair competition, and child labour, all thinking men will applaud the act as a progressive step.

What we are witnessing is nothing more than an extension of a very old principle, namely, that any community has always assumed the right to govern industry in its midst in so far as such industry affects the common welfare. In this particular instance we may find out how far the community may go with its regulatory power without destroying individual initiative.

And when the prophets disagree the case is even more serious. The history of depreciated currency is well known. King Henry VIII indulged in such an experiment with the usual results, and it has been tried at many other times and places. Yet to-day we have professional economists who presumably have made a study of such things divided in their opinions on monetary matters of all sorts. Some believe in a gold standard, some do not; some believe in "moderate" inflation, others will have none of it. To an engineer this is most disconcerting. In vain one inquires in engineering fashion, "What are the facts?" There are plenty of opinions, but few convincing facts. Again, I know of no economic theory that justifies the destruction of food and cattle while thousands want for the necessities of life. On the one hand the President is committed to an increase in prices, while at the same time we have heard frantic appeals from other government officials to keep prices down. Such wide disagreements in economic policy are, as I have said, very disconcerting to the engineer whose methods are so much more direct and factual in their approach. They would appear ludicrous, indeed, if they were not so tragic in their implication. One is reminded of Omar who listened to:

> "Doctor and saint and heard great argument
> About it and about; but evermore
> Came out by the same door wherein I went."

And always in times of depression the voices of the prophets are heard calling down the wrath of heaven on those who have led us into the wilderness of want and despair. In the last decade of the last century there was such an outcry known as "muckraking." It was directed, as is always the case, against the industrial, business, and financial leaders. Unfortunately, there are always a few such leaders who, through lack of rectitude, give strength to such attacks, though the great majority of our industrial, commercial, and banking leaders are honest, hardworking, and human. I would suggest that right now is a good time to re-read Elbert Hubbard's "Message to Garcia." The great difficulty is that these outcries are undiscriminating in character and defame the good with the bad. Theodore Roosevelt, speaking in 1906, defined muckraking as "the effort to make financial or political profit out of the destruction of character." We are hearing not a little of this sort of thing to-day, and this "anti-industrial complex," as Dr. Virgil Jordan has called it, is a disturbing matter. It fosters a belief on the part of many that modern industrial methods are a menace to our national life, and should be sharply curbed; a belief that those who manage industry have obtained the lion's share of the benefits as compared to the actual worker, and that we should "take from those that have and give to those who have not," as one prominent senator has expressed it. No one doubts that a more equitable distribution of the national income would be desirable, both on economic and humane grounds, and, incidentally, if taxes, direct and indirect, are an index, such a distribution is fairly well under way.

But there are only two horns to this dilemma. Either we must go to widely extended outright government ownership with its mediocre initiative and leadership, or continue to depend upon individual efforts. The proportion of men in any group, great or small, competent to initiate and manage large enterprises of any kind is very small. In a similar way the scientists and engineers constitute a very small percentage of the population. This group can be regulated and regimented just so far and still produce its best results. Genius does not work well in harness, and the old law of diminishing returns applies here as elsewhere, and if regimentation is pressed too far the result cannot fail to be as thus described by Dr. Virgil Jordan:

> In the first place, and most fundamentally, it must lead to a gradual lowering of the standard of living, or at least to a greatly retarded rise in the standard of living. The economic welfare of any nation is dependent basically upon its output of work, the volume of goods and services or real wealth that it produces. We may shift debt burdens from one group to another and artificially redistribute wealth and income; but no nation can raise its standard of living merely by raising prices and wages through monetary manipulation or group agreement, or through curtailment of output and restriction of productive effort. The most important factor in the productive accomplishment of any people is the enterprise and effort of individuals, as investors, speculators, inventors, organisers, and managers. The crippling of individual initiative and enterprise through the expanding of bureaucratic agencies must inevitably lower the level of effective production, restrict opportunities for employment, and reduce the standard of living.

These are thought-provoking words. The greatest asset that any nation can possess is the skill, knowledge, and initiative of its industrial and business leaders, and probably we can better afford to put a few of our too ambitious leaders in the penitentiary, occasionally, rather than exterminate or suppress the entire group.

In any case, we are due soon to find out how far we can legislate ourselves into prosperity, or rather we shall find out perhaps how far we may assist natural economic laws through legislation. And the experience may be trying for many of us.

The greatest difficulty with the economic prophet lies, of course, in his panaceas, especially when they assume, as they often do, the form of legal enactments. This is particularly true when these enactments aim at changes or corrections of our ethical code. It is difficult for him to see that law itself is an expression of our ethics and no law can possibly be effective that does not have the support of the vast majority of the people. If I have any criticism of the New Deal it is the apparent effort under the N R A to compel men to be just and fair. The intent is good, but the difficulties are great. No man's ethics, politics, or religion has ever been changed because of the enactment of any law. Our ethical beliefs are a complex composite built up from inheritance, environment, and experience, and are not changed by change in the law. Witness the many thousands that have died for their religious or political faith. If all men were just and fair we should have little need of industrial legislation of any kind. But unfortunately this country contains a large number of people in whom justice does not reside and who do not hesitate to take advantage of their neighbour even though they may transgress the law in so doing. It will require an immense police force to make any such enactment as the N R A effective. Our recent experience with prohibition has apparently taught us very little concerning the regulation of business ethics. It is impossible to legislate goodness into the hearts of unregenerate persons. On the whole, we have made much progress during the last century toward a more enlightened and fairer industrial system, and our greatest hope lies, not in legislation, but in higher ethical standards on the part of those who control industry, commerce, and banking.

And, again, there is nothing new in this statement. If we will but listen we may hear many voices from the distant past repeating over and over again the eternal verities of life, and sages in all times have tried to epitomise these truths for our guidance. Plato tells as an ancient Greek myth how the great god Zeus, when he placed life upon the earth, gave to each bird and beast strength or swiftness according to its needs in order to survive, and to man he gave reason and fire. Thus armed, man was able to hold his own against the beasts of the field. But when men began to live in cities they were so vicious toward each other that Zeus feared the race might become extinct. He therefore sent his messenger Hermes to distribute justice and the sense of shame in every human heart, for, he said, without these men would eventually exterminate themselves. This would appear still to hold true, and perhaps what we most need is not more legislation, but higher ideals of justice and fair play. Be assured in any case that whatever may be good in the Square Deal, or the New Freedom, or the New Deal, will also be found in old deals, for the basis of social justice is eternal and does not change.

LARGE AMERICAN TOLL BRIDGES.

With the rapid spread of road construction in the United States, and the enormous increase in the use of automobiles and motor trucks, there came about the construction of a number of bridges over large rivers to link up main highway routes. In many cases the cost of such structures was far too great to be provided by the highway departments of the several States, and this condition led to the organisation of private bridge companies, which repaid themselves by toll charges, while in most cases the bridges revert to State ownership after a term of years. Several such bridges have been built over the Mississippi River. This class of enterprise dropped to a minimum in the depression period, but may revive with a revival of prosperity and the loosening of funds. An example of such structures is one over the Delaware River, near Philadelphia. This bridge consists of a steel bowstring arch of 538ft., with the roadway forming the chord of the arch and a double-leaf rolling-lift bascule of 282ft., these two spans covering the main channel. On each side they are flanked by a 735ft. continuous truss forming three spans of 245ft. and then a plate girder viaduct for 700ft. to the approach embankment. The total length including approaches is about 4800ft. The rolling-lift bascule is of an unusual type, since the two leaves when closed act as an arch, while in most such bridges the leaves act as two independent cantilevers. The clearance above water level is 64ft. under the arch span and 54ft. under the closed bascule. Four traffic lanes are provided on a 38ft. concrete roadway, and for pedestrians there are two walks 7ft. wide outside of the trusses. When under load, the trusses of the bascule span seat against reaction bearings at the centre and in the piers. Each leaf is operated by a pair of electrically driven pinions, which engage horizontal racks in the piers. To reduce weight the floor is composed of two layers of planking, covered with a wearing surface of asphalt planks or slabs.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Leo C. Steinle, Ltd., inform us that on and after January 28th, 1935, their address will be 93, Albert Embankment, London, S.E.11.

James Beresford and Son, Ltd., Cato-street Works, Birmingham, have opened a new London office and showrooms at 28, Victoria-street, London, W.1, where they are displaying "Beresford-Stork" centrifugal self-priming pumps and "Beresford-Garvens" submersible bore-hole pumps and motor units.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

Holden and Brooke, Ltd., Manchester, have recently received from India three contracts calling for a total of fifty-five motor-driven centrifugal pumps.

Sturtevant Engineering Company, Ltd., 147, Queen Victoria-street, London, E.C. 4, has received an order from the City of Leicester Electricity Department for an electrostatic precipitator to clean the flue gases from a new pulverised fuel-fired boiler.

Erratum.—On page 74 of our issue of January 18th—"Protective Measures at Level Crossings"—for R. A. Ryvel read R. A. Ryves.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

Applications for Higher Duties.

Considerable interest attaches to the notification of the Import Duties Advisory Committee that it has under consideration applications for an increase in the import duties on iron and steel (including alloy steel) of the following descriptions:—Blooms, billets, slabs and sheet and tin-plate bars (other than of wrought iron produced by puddling with charcoal from pig iron smelted wholly with charcoal); iron and steel rails weighing less than 36 lb. per yard. These applications are being considered in conjunction with the applications advertised on May 30th and June 13th, 1934, for increased duties on iron and steel bars, &c., and girders, &c. The application made on May 30th was for an increase in the import duty on: Iron and steel (including alloy steel) of the following descriptions:—Bars and rods of all kinds (other than wrought iron produced by puddling with charcoal from pig iron smelted wholly with charcoal); angles, shapes and sections of all kinds, whether fabricated or not; hoop and strip of all kinds (other than hot-rolled strip over 10in. wide in coils weighing more than 3 cwt., and band-saw strip 3½in. wide and over and from 19 to 12 gauge in thickness). The application made on June 13th was for a higher duty on: Iron and steel girders, beams, joists and pillars, whether fabricated or not. Some surprise has been occasioned that the Import Duties Advisory Committee has not reached a decision upon the latter two applications. It is understood, however, that before making any recommendation it desired the British iron and steel industry to get into touch with the Continental steel makers in order to see if an international trade arrangement were possible. A meeting was held at the end of last year, which failed to produce any results. It has been stated that a section of the Continental steel makers has shown reluctance to renew the various agreements existing between sections of the British and Continental steel trade unless a comprehensive understanding can be reached. The ship plate agreement, it is understood, has been only temporarily renewed for this reason; but, on the other hand, the international tin-plate arrangement has been strengthened by the adhesion of the Italian makers.

The Pig Iron Market.

The customary January conditions have developed in the pig iron market. After a more than usually active rush of new buying business has become of rather a hand-to-mouth character. These conditions seem to rule in practically all districts, and may be in a large measure due to the extensive covering over long periods ahead which took place at the end of last year. The Cleveland market for foundry iron has been distinctly quiet, and although fair deliveries are being made to Scottish consumers, the tonnage is not up to expectations. The local foundries have taken heavy quantities of iron against contracts, and a certain amount of new business has come forward from consumers who have found it necessary to supplement their supplies by small purchases. Expectations are rife of fresh buying on an improved scale from Scottish users, and it is anticipated that the present slackness in deliveries will be only a passing phase. A satisfactory feature of the market has been the increase in the inquiry from abroad, and makers have shown more inclination to compete for this class of business, although they have all along been willing to accept lower prices for export than for the home trade in order to keep their foreign connections. In the Midlands the improvement noticeable recently in the demand for foundry pig iron has been maintained. Business with the light castings foundries has expanded of late, with the result that the order books of the pig iron producers are now better than they were at the end of the year. The engineering industry is also taking considerable quantities of iron, and the increase in the requirements of this industry has been one of the favourable signs of the New Year's trading. Specifications are reaching the producing concerns at a satisfactory rate, and the tone of the market has strengthened considerably during the past fortnight. The Scottish market has been moderately busy, the demand being principally from the light castings foundries. The engineering trades and the foundries producing heavy castings have taken fair deliveries, but have not placed much new business. Consumers of hematite in all parts of the country seem to be well bought, and at the moment are not showing a great deal of interest in the market. No complaint can be found with the way in which deliveries are being accepted, although perhaps they are not on such a heavy scale as in the middle of December. Recently, export business has shown signs of expanding, but the makers do not seem anxious to book foreign business far forward at the current rate of 63s. 6d. f.o.b.

Scotland and the North.

Normal conditions now rule in the Scottish steel trade and all the big steel works are producing considerable quantities of re-rolled products. For some weeks to come the shipyards will continue to take heavy tonnages, although the new business which has been placed of late has been barely sufficient to make good the loss occasioned by the completion of contracts. In addition to the demand from the shipyards, the constructional engineers in Scotland, who have comfortably filled order books, are taking good deliveries of sections and joists. It is also anticipated that some good contracts for these materials will be placed shortly. At the moment, however, new business in this direction is somewhat on the quiet side. The situation in the black sheet trade is not too good and there is a certain amount of idle plant. The demand is still principally upon home account and restricted to the heavier gauges. The motor car manufacturers are probably the trade's best customers and in some cases are exercising pressure to get deliveries. The overseas markets are not taking their customary quantities of the thinner gauges and at present there seems little prospect of the market for this material expanding. The re-rolling works did not re-start after the holidays with so much work in hand as they anticipated, but lately some orders have come along which have improved their position. Nevertheless, operations in this branch of the industry are upon a somewhat low scale and fresh complaints are heard of the competition of Continental and English material in the Scottish market. In Lancashire most of the important consumers of finished steel have covered their requirements for some little time and are not yet prepared to add substantially to their commitments. This seems to apply particularly to small steel bars and small sections. This branch of the trade is experiencing some scarcity of new business, which is probably only temporary, as consumers appear to have a fair amount of work in hand. The constructional engineering trades in this district are busy and are likely to be more so in the not distant future, but most of them are working on contracts and are not showing much disposition to place fresh orders. It is expected that the Lancashire municipal authorities will undertake a considerable amount of public work in the nature of strengthening and reconstructing bridges, and this should provide orders for a considerable tonnage of steel for the works in the county. Business in special steels and bright-drawn bars has improved of late, but there has been a poor demand for plates and sheets of all descriptions.

The North-East Coast and Yorkshire.

Busy conditions are in evidence at the steel works on the North-East Coast. Some of the departments are fully employed and likely to remain so for some time. It is expected that the orders for steel rails foreshadowed in the railway companies' programmes for 1935 will soon be given out and that the rail mills will receive considerable additions to their order books. Business in structural steel, which was active before the holidays, has increased in volume, and as the constructional engineers on this coast are well supplied with work a further expansion is looked for. An indication of the soundness of the position is afforded by the recent lighting up of a steel furnace at the Skinningrove works. There is a good volume of business passing in steel sheets, chiefly in the heavier gauges for the home market. The export demand for this material still lags, although some slight improvement is also noticeable in this direction. The plate mills are better employed than for some time, and this section of the industry has been helped by the receipt of Russian orders totalling 8000 tons. The shipbuilders are still some way from being busy, but hopes are entertained that some of the inquiries for new ships recently circulated will result in fresh work for the yards on this coast. New business in semi-finished steel continues to hang fire, but this is principally because consumers have important balances of contracts to work off. The works producing billets are making heavy deliveries and the imports of this class of material into this district show a tendency to decrease. Business in sheet bars has improved recently as a result of the firmer conditions in the sheet market. The Yorkshire steel trade has now fully regained the activity ruling before the holidays. The demand for basic steel is at a high level and all the producing works are busy. One of the best employed sections of the Sheffield industry is the stainless steel department. Production has increased lately, but consumers' requirements seem to have expanded to an even greater extent. Some disappointment is felt at the quiet conditions ruling in the tool steel market, although the makers still have plenty of work on their books.

The Midlands and South Wales.

The Midland steel trade is working at a steady rate, and on the whole the position is better than is usual at this time of the year. This is particularly the case in the structural steel market, which ended the year on a rather quiet note. During the past week, however, there has been a spurt in demand and the constructional engineers have placed fair contracts for joists and sections. At the same time, some makers say that the tonnage of orders in hand for joists is not sufficient to keep them steadily employed for more than a week or two. The plate mills, with one or two exceptions, are not well provided with orders, but anticipate that railway requirements will help to improve their position. The demand for boiler plates, which was a little brighter recently, has again deteriorated. Some business has been transacted in chequer plates lately, the controlled price of which is £10 7s. 6d. for ¼in. Business in small steel bars and strip is fairly active, although the turnover has not been so heavy as in the autumn. Opinions seem to vary as to the volume of orders which are going abroad. Some makers complain that they are losing business to the Continent. This may be the case, as the Continental price is £7 10s. to £8 10s. for strip and £7 1s 6d for bars, compared with the British price of £9 7s. for strip and £8 12s. less a rebate for small bars. It is doubtful, however, if the tonnage going abroad is so heavy as was the case even a few weeks ago. The works outside the Association appear to be securing the bulk of the business offering at prices of £7 10s. to £7 12s. 6d. for small bars and about £8 15s. for strip. Conditions in the sheet market are only moderately satisfactory. The demand from the motor car manufacturers has not yet regained the strength it showed before the holidays, but during the past week there has been definite evidence of improvement. The tin-plate market in South Wales has been rather quiet, but this is probably owing to consumers having contracted for their supplies for the first quarter. A satisfactory feature of the position is that deliveries are being freely taken up. The tin-plate trade is usually quiet at this time of the year, and some works complain that specifications are not reaching them as regularly as they could wish. Most of the works, however, carry good order books and their requirements are keeping the manufacturers of tin-plate bars busy.

Current Business.

The ventilation equipment of five passenger liners being built in Germany for the Norddeutscher Lloyd, and Hamburg-America lines has been placed with Thermotank, Ltd., of Govan. It is announced that the Anglo-Saxon Oil Company has decided to proceed with a scheme for the building of ten tankers over a period of ten years, as a result of the satisfactory performance of a 12,100-ton oil tanker recently completed by Swan, Hunter and Wigham Richardson, of Wallsend. An order for a coaster of 700 tons has been placed by Sir A. M. Sutherland with R. and W. Hawthorn, Leslie and Co., Ltd., of Hebburn-on-Tyne. Higgs Motors, Ltd., of Witton, Birmingham, have experienced difficulty in obtaining payment for goods shipped to Iceland owing to restrictions by the Government of the country on the export of gold, and recently received a consignment of haddock in settlement of an account. The firm accepted the consignment and sold it in the appropriate market, and state that they intend to continue their business relations with Iceland. The British Thomson-Houston Company, Ltd., of Rugby, lately received an order for electrical equipment for the Port Jackson Corporation, as well as for the electrical equipment of a passenger ferry boat. The Department of Overseas Trade announces that the following tenders are open:—Johannesburg, Union Tender and Supplies Board: 12,439 cast iron spigot and socket pipes, 3½in. by 9ft. (Pretoria, March 1st); South African Railways and Harbours: one or more trailers of 20-ton load capacity and one or more articulated trailers of 15 to 20-ton capacity (South Africa, March 18th); Singapore Municipality: 1500 feet of ¼in., 1000 feet of ⅜in., and 1500 feet of 1in. high-pressure copper tubes (London or Singapore, February 14th); Siam, Royal State Railways: 200 cast steel wheels (Bangkok, February 9th); Australia, Posts and Telegraphs Department: common battery and magneto private branch exchange cordless switchboards (Melbourne, March 19th); New Zealand, Posts and Telegraphs Department: 1250 bundles of copper binders, No. 2, and 1250 bundles of copper tapes, No. 1, to B.S.S. 177/1927 (Wellington, March 22nd); New South Wales, Department of Railways: ventilating and air conditioning plant (Sydney, February 27th).

Copper and Tin.

Conditions in the market for electrolytic copper have become somewhat lethargic. The producers have sold heavily at times, particularly the Chilean and Rhodesian mines; but, on the whole, these offerings have been well absorbed. Prices have moved within a narrow margin, and have been less affected by these sales than might have been expected. The Italian market has taken some good quantities of copper for sulphate making, and further purchases are expected. Business with Germany continues to hang fire. There is no doubt that consumers in that country would be glad to take large tonnages, but the question of payment stands in the way. A certain amount of business has been done by barter, but these arrangements take time, and do not always work out satisfactorily. No fresh news has transpired regarding the negotiations between the producers to control production. During December the world's stocks of copper increased by 10,500 tons to 494,000 tons. This, however, was a reduction on the year, as the total stocks on December 31st, 1933, were 642,000 tons. The world's stocks at the end of December included 373,000 tons of refined copper in the United States and 121,000 tons elsewhere. Brandeis, Goldschmidt and Co., in their review of the copper industry for the year, give the consumption in 1934 as 1,320,000 tons, compared with 1,110,000 tons in 1933. The consumption last year was, in fact, the largest since the year 1928–29. Rather firmer conditions have ruled in the standard market of late, and prices have shown a tendency to advance. This seems to be due more to the technical position of the market than to any change in general conditions. . . . The chief feature of the tin market has been the increase in the backwardation to £4. This was not unexpected, and is partly due to the movement of tin from this country to America, and the consequent reduction in the stocks here. The industrial demand for the metal does not improve, but, on the other hand, it shows no signs of decreasing. American buying has not expanded to any great extent. A favourable impression is created in the market by the improvement reported in the American tin-consuming industries. It is expected that the January statistics will again show a decrease in the visible supply, and this may partly account for the firmer tone in the market.

The Spelter Position.

Recently there has been some slight improvement in the tone of the spelter market, but prices have moved within narrow limits. The dissolution of the International Spelter Cartel has had no influence upon the market, but anticipations of increased imports of spelter into this country from Poland and Belgium are likely to keep the price down for a time. The uncertainty felt as a result of the inquiry now being conducted by the Import Duties Advisory Committee will also have an adverse effect upon the market until the result is known. Consumers are finding it difficult to obtain Empire brands, and it is possible that some of the foreign spelter arriving will be taken up and the duty paid. At present premiums of 22s. 6d. to 25s. are required upon prompt duty-free and about 15s. on metal for April delivery. The world production of spelter, according to Brandeis Goldschmidt and Co., reached 1,135,000 tons in 1934, compared with 995,000 tons in the previous year; whilst consumption last year is given at 1,120,000 tons, against about 1,005,000 tons in 1933. The consumption in Great Britain was 170,000 tons in 1934, compared with 125,000 tons in 1933.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.: plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	(*D/d Teesside Area*)	
N.E. COAST—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 8 6	3 2 0
No. 1	3 9 0	3 2 6
Cleveland—	(*D/d Teesside Area*)	
No. 1	3 10 0	3 4 0
No. 3 G.M.B.	3 7 6	3 1 6
No. 4 Forge	3 6 6	3 0 6
Basic (*Less 5/– rebate*)	3 7 6	—
MIDLANDS—		
Staffs.—	(*Delivered to Black Country Station*)	
North Staffs. Foundry	3 11 0	—
„ „ Forge	3 6 6	—
Basic (*Less 5/– rebate*)	3 12 6	—
Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 11 0	—
No. 1 Foundry, ditto	3 12 6	—
No. 3 Foundry, ditto	3 10 0	—
Basic, d/d (*Less 5/– rebate*)	3 7 6	—
N.W. COAST—		
Hematite Mixed Nos.	3 12 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

MANUFACTURED IRON.

	Home.	Export.
LANCS.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. YORKS.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
MIDLANDS—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	7 5 0 to 7 15 0	—
SCOTLAND—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. COAST—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

	Home.	Export.
LONDON AND THE SOUTH—	£ s. d.	£ s. d.
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	8 14 6	—
Flats, 5in. and under	8 14 6	7 2 6
Plates, ¼in. (basis)	9 0 0	7 15 0
„ 7/16in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ 9/16in.	9 15 0	8 10 0
„ ⅝in.	9 10 0	8 5 0
NORTH-EAST COAST—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Plates, ¼in.	8 15 0	7 15 0
„ 7/16in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ 9/16in.	9 10 0	8 10 0
„ ⅝in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 5 0	8 5 0
MIDLANDS, AND LEEDS AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ 7/16in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ 9/16in.	9 12 6	8 10 0
„ ⅝in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 7 6 .. 7 15 0 to	8 5 0

STEEL (*continued*).

	Home.	Export.
GLASGOW AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 15 0	7 15 0
„ 7/16in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ 9/16in.	9 10 0	8 10 0
„ ⅝in.	9 5 0	8 5 0
Boiler Plates	9 5 0	8 5 0
SOUTH WALES AREA—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 0
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ 7/16in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ 9/16in.	9 12 6	8 10 0
„ ⅝in.	9 10 0	8 5 0

IRELAND—	BELFAST.	REST OF IRELAND.
	£ s. d.	£ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¼in. (basis)	9 0 0	9 2 6
„ 7/16in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ 9/16in.	9 15 0	9 17 6
„ ⅝in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

	Home.	Export.
Sheets.	£ s. d.	£ s. d.
10-G. to 13-G., f.o.r.	9 0 0	8 15 0
14-G. to 20-G., d/d	10 5 0	9 0 0
21-G. to 24-G., d/d	10 10 0	9 5 0
25-G. to 27-G., d/d	11 2 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 0 0
2-ton to 4-ton lots	13 7 6
Under 2 tons	15 0 0

Export: £16 12s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.

20 by 14 basis, f.o.b. Bristol Channel Ports, 18/2.

Tin-plate Bars, d/d South Wales Works, £5 7s. 6d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 tons	5 15 0
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 12 6	7/–
„ „ 8 p.c. to 10 p.c.	£21 12 6	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 0 0	11/–
„ „ „ 1 p.c. carbon	£38 15 0	12/–
„ „ „ 0·70 p.c. carbon	£42 0 0	12/6
„ „ „ carbon free	10d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£13 0 0 scale 5/– p.u.	
„ „ 75 p.c.	£18 7 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Ferro Cobalt	5/3d. per lb.	

NON-FERROUS METALS.

Official Prices, January 23rd.

COPPER—		
Cash	£28 1 3 to £28 2 6	
Three months	£28 6 3 to £28 7 6	
Electrolytic	£31 0 0 to £31 10 0	
Best Selected Ingots, d/d Birmingham	£31 15 0	
Sheets, Hot Rolled	£58 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	9½d.	9½d.
„ Brazed (basis)	9½d.	9½d.
BRASS—		
Ingots, 70/30, d/d Birmingham	£27 0 0 to £29 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	8¾d.	8¾d.
„ Brazed	10¾d.	10¾d.
TIN—		
Cash	£232 7 6 to £232 10 0	
Three months	£228 17 6 to £229 0 0	
LEAD:	£10 8 9 to £10 11 3	
SPELTER:	£11 18 9 to £12 2 6	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
f.o.b. Grangemouth)—Navigation Unscreened	13/– to 13/6
„ Glasgow—Ell	16/– to 16/6
„ „ Splint	17/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	14/– to 14/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Prime Steam	14/–
Unscreened Navigation	12/6 to 13/–
LOTHIANS—	
(f.o.b. Leith)—Hartley Primes	14/– to 14/6
Secondary Steam	13/–

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	18/6 to 21/6
Furnace Coke	15/– to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	14/6 to 14/9
„ Second	13/3
„ Best Small	11/–
Unscreened	12/6 to 13/6
DURHAM—	
Best Gas	14/8
Foundry Coke	18/6 to 22/6

SHEFFIELD—	Inland.
Best Hand-picked Branch	24/– to 26/–
South Yorkshire Best	21/– to 23/–
South Yorkshire Seconds	17/6 to 19/–
Rough Slacks	8/– to 9/–
Nutty Slacks	7/– to 8/6

SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Bunker Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 26/–
Foundry Coke	24/– to 37/6
Furnace Coke	19/– to 21/6
Patent Fuel	21/–
SWANSEA—	
Anthracite Coals:	
Best Large	37/6 to 40/–
Machine-made Cobbles	41/– to 51/–
Nuts	40/– to 50/–
Beans	25/– to 30/–
Peas	19/– to 22/6
Rubbly Culm	11/6 to 12/–
Steam Coals:	
Large	18/– to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ¼d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Saar Coal.

THE retrocession of the Saar collieries to Germany on payment of an agreed purchase price of 900 million francs is to be effected under conditions which French coalowners fear will aggravate a competition that was to have been eliminated. During the fifteen years that the Saar mines were worked by the Mines Domaniales de la Sarre the quantity of coal entering France was restricted to about 4,000,000 tons a year, the surplus being disposed of abroad. Care was taken to send the coal as much as possible beyond the distributing area of French coal; but, nevertheless, the Saar coal did compete with coal from the Nord, notably in the Paris district, where it was largely employed in power stations. At the conference in Rome to settle financial matters arising out of the transference of the Saar to Germany that country undertook to pay for the mines in kind, and it is believed that this will take the form of coal supplies, though nothing is definitely known regarding the conditions under which the payment in kind will be effected. The situation is viewed with anxiety by French coalowners, who have impressed upon the Government the necessity of keeping the coal supplies strictly within the quota allowed to Germany, and their claims are supported by the Parliamentary Mines Commission, so that unless the French Government has already entered into a definite agreement with Germany there is a probability that the full German quota will be utilised for the payment of the Saar mines. Other coal exporting countries can hardly consent to the German consignments exceeding the total allotted by quotas. In that case the coal deficit in France resulting from the transference of the Saar mines to Germany must be made good either by an increased production of French coal or by additional consignments from abroad. The French collieries can make up for the deficiency in their own distributing areas, but it is likely that more foreign coal will be needed elsewhere, in which event it may be necessary to increase the quotas for foreign coal. Another matter that is causing concern to French coalowners is the prospect of a number of Saar miners being drafted into the northern collieries through fear of reprisals. There may be no justification for that fear, but it raises a problem at a time when there is so much unemployment amongst French miners.

Import Quotas.

Some prominence has been given abroad lately to the alleged intention of the Government to suppress import quotas which were instituted as a temporary expedient and appeared to have settled down as a permanent factor in foreign trade. For some classes of goods, such as machine tools, quotas have been abolished, and now and then a new category of product is added to the list, so that there is a prospect of quotas gradually disappearing in the future. Every time a quota is removed, however, import duties are increased to an extent that should satisfy manufacturers who refuse to admit the suppression of quotas unless they are replaced by prohibitive duties. In these circumstances quotas are the lesser of two evils. Import duties, however, are raised by decree and are of a temporary character, and the manipulation of quotas and tariffs is an attempt to reach an adjustment which may eventually permit of the preparation of a suitable Tariff Bill. There can be little hope of that Bill being introduced so long as economic and currency difficulties abroad make it impossible to pursue a settled policy, but it is recognised that, in principle, import quotas are detrimental to the national interest, although regarded as indispensable by some manufacturing interests, and they are only maintained as a convenient method of saving the country from the mass importation of cheap goods. It is by no means certain that the substitution of exceptionally high tariffs for import quotas is satisfactory for the future of foreign trade. If they were embodied in a Tariff Bill there would be an end to hopes of trade development, and the experimental adjustment of tariffs in the place of import quotas is intended to provide elements of appreciation when the time comes to prepare the new Bill. New import duties fixed by decree, and capable of modification, therefore need close attention.

The Engineers' Federation.

The associations, societies, and syndicates of engineers have each definite social, professional or material aims, and each is governed by different statutory laws. In 1929 there was formed a federation of all these bodies under the name of the Fédération des Associations, Sociétés et Syndicats Français d'Ingénieurs, comprising twenty-five such groups with a total membership of more than 50,000. There was formerly some criticism over a supposed lack of initiative on the part of the Federation in dealing with problems interesting the engineering profession, but at its annual meeting held in Paris last week the Federation was able to render a good account of its achievements in helping to constitute the parliamentary group of engineers and and in securing representation on national councils. Its influence was exerted in favour of reducing the number of engineers' degrees, limiting the number of students, and opposing the creation of new schools. The past year was notable for the passing of the law which gave a definite status to engineers, and the work of the Federation did much to extend their influence. Nevertheless, the material situation of engineers has not improved, and a Government proposal to adjust the supply of engineers to the demand by fixing the number of students each year by means of eliminating examinations is diversely criticised.

The 1937 Exhibition.

The plans that have been submitted in competition for changing the aspect of vestiges of former exhibitions in order to provide something entirely new for the Paris Exhibition of 1937 are not without engineering interest. The main entrance will be at the Trocadéro, which was erected as a temporary building for the exhibition of 1867. That exotic structure will be completely concealed by external buildings, and it is also proposed to modify the aspect of the Eiffel Tower, although the problem offers so many difficulties that it is doubtful whether anything will be done to alter its distinctive character.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

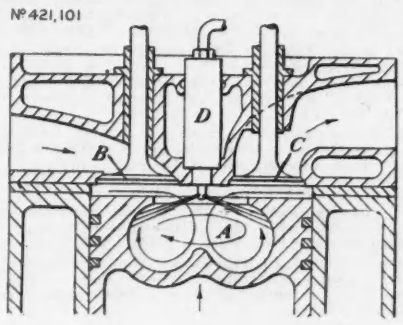
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

421,101. April 12th, 1934.—COMBUSTION CHAMBERS, H. Saurer, Arbon, Switzerland.

In order to increase the turbulence of the charge of fuel and air, and thus promote its combustion, the inventor provides an annular combustion chamber A in the top of the piston (it

Nº 421,101

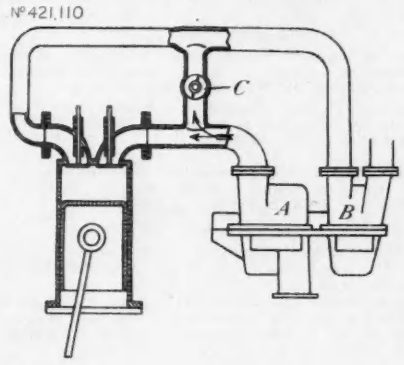


may also be in the cylinder head), into which the air is led tangentially through the inlet valve B. The opening connecting the combustion chamber with the cylinder bore has an area of from one-sixth to one-third of that of the cylinder. The exhaust valve C and injection nozzle D are normal.—*December 13th*, 1934.

421,110. June 6th, 1934.—SUPERCHARGED ENGINES, Aktiengesellschaft Brown Boveri et Cie, Baden, Switzerland.

In this system of supercharging the air necessary is supplied by the blower A driven by the exhaust gas turbine B. The

Nº 421,110



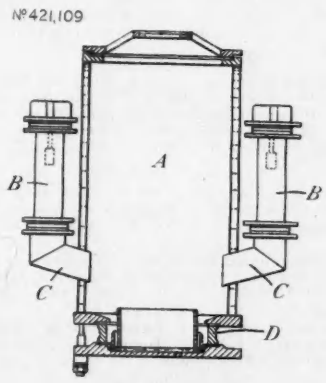
blower is capable of delivering more air than is required by the engine, and the surplus is sent by the by-pass C into the exhaust pipe, so that it helps to cool the exhaust gases and relieve the turbine blading of high-temperature troubles.—*December 17th*, 1934.

TRANSFORMERS AND CONVERTERS.

421,109. May 29th, 1934.—METALLIC VAPOUR ARC CONVERTERS, The English Electric Company, Ltd., Queen's House, 28, Kingsway, London, W.C.2.

In this mercury vapour rectifier the main cathode vessel

Nº 421,109



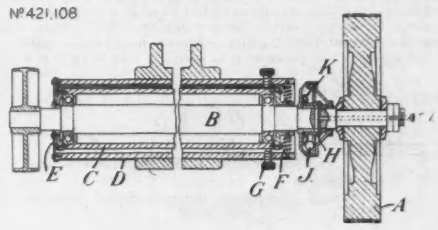
A is of metal. The anode containers B B are of glass, but are connected with the main vessel by metal branches C C. The vessel is also insulated from its base by the glass ring D. The anode vessels are consequently well exposed for air cooling.—*December 13th*, 1934.

MEASURING AND TESTING INSTRUMENTS.

421,108. May 23rd, 1934.—MEANS FOR DYNAMICALLY BALANCING MACHINES, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

This invention is concerned with balancing abrasive wheels and other high-speed rotary cutters. The wheel A is carried by the spindle B, mounted in the ball-bearing casing C. This casing is arranged in the housing D, to which it is attached at the left-hand end by the flexible diaphragm E. At the other end it is centred by the springs F and set screws G. The balancing device comprises the case H, fixed on the shaft, within which there are two steel balls, one of them shown at J. If the wheel A is out of balance when it is run up, and the set screws G are

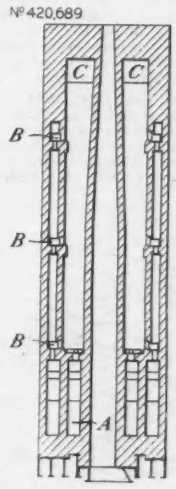
Nº 421,108



loose, the spindle will naturally vibrate. But if the two balls J are freed to move round the casing H by releasing the clutch K by the presser L, the balls will take up positions to produce a dynamic balance of the whole system. The set screws G are then tightened up again.—*December 13th*, 1934.

GAS PRODUCERS.

Nº 420,689



420,689. June 12th, 1933.—HEATING COKE OVENS, Compagnie Générale de Construction de Fours, 8, Place des Etats-Unis, Mont rouge (Seine), France.

In this coke oven heating is effected by gas supplied through the flue A and burned by the admission of air at B B B. The spent gases pass, by the flue C C, to the opposite side of the retort, where they heat the brickwork for a regenerative system of working.—*December 6th*, 1934.

METALLURGY.

421,014. November 23rd, 1933.—CEMENTATION OF IRON, STEEL, AND ALLOYS THEREOF, Deutsche Gold- und Silber-Scheideanstalt vormals Roessler, Weissfrauenstrasse 7/9, Frankfurt a.M., Germany.

This invention relates to melt baths for the cementation of iron and steel and alloys of iron and steel with other metals, such as nickel, chromium, vanadium, molybedenum, and tungsten. Melt baths according to this invention are formed by fusing together carbides of the alkaline earth metals, for example, barium carbide or calcium carbide, or mixtures of the same and inert salts, such as common salt, potassium chloride, or mixtures of the same in the presence of alkaline-reacting agents. Alkali carbonates, such as sodium carbonate, hydroxides, such as caustic soda, or oxides, and such as sodium oxide, may be employed as alkaline-reacting agents. The quantity of carbides used may vary within relatively wide limits, for example, between 2 and 15 per cent., about 5 to 10 per cent. of carbide being a suitable quantity. It has been found that in certain cases excellent results are obtained by employing only 2 to 5 per cent. of caustic soda, and that, on the other hand, detrimental effects are not observed in the presence of larger quantities, for example, between 15 per cent. and 20 per cent. It has even been found that excellent results may be obtained by employing carbonates, such as sodium carbonate in quantities of about 50 per cent. The operation of cementing in the baths is carried out by dipping the articles to be cemented in the bath and maintaining them therein for some time at a suitable temperature. The cementation temperatures depend, *inter alia*, on the desired depths of cementation. Temperatures between 700 deg. and 1050 deg. Cent., preferably between 750 deg. and 950 deg. Cent., have proved to be particularly suitable. The carburising effects obtained with cementation baths, according to this invention, reach, it is said, great depths. Thus, for example, it has been possible readily to obtain case-hardening depths of 2·4 mm. in six hours at 930 deg. Cent. Over-carburisation has not been observed in cementations with melt baths according to the invention. A further advantage of cementing with the bath according to this invention is that the transition from the cemented zone to the non-cemented zone is very gradual and that excellent hardening effects are obtained.—*December 12th*, 1934.

421,104. May 3rd, 1934.—ALLOY CAST IRON CASTINGS, Bradley and Foster, Ltd., Darlaston Blast-furnaces, Darlaston, Staffordshire; and J. E. Hurst and W. H. Lewis.

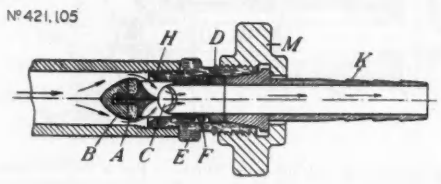
This invention concerns so-called chilled and grey alloy cast iron castings, more especially in the form of machinery parts intended for service under heavy duty conditions. For example, the invention concerns chilled and grain rolls for the rolling or crushing of metals. Accordingly the castings include as an alloying constituent in the metal from 0·25 to 10 per cent. of tungsten reckoned upon the total weight of the casting, with or without a smaller proportion of chromium, for example, and preferably, a proportion ranging from one-fifth to one-third of the proportion present of tungsten. Two examples of such alloys are given. In the first the casting was of average thickness of approximately 1in. and upon analysis its composition was as follows:—Total carbon, 2·65 per cent.; silicon, 1·50 per cent.; manganese, 0·50 per cent.; sulphur, 0·04 per cent.; phosphorus, 0·06 per cent.; chromium, 1·80 per cent.; tungsten, 7·40 per cent.; vanadium, 0·36 per cent. The other was also of an average thickness of approximately 1in. and the composition upon analysis was found to be as follows:—Total carbon, 3·10 per cent.; silicon, 1·83 per cent.; manganese, 0·30 per cent.; sulphur, 0·04 per cent.; phosphorus, 0·06 per cent.; chromium, 1·18 per cent.; tungsten, 4·76 per cent.; vanadium, 0·14 per cent. Physical and mechanical tests taken on samples from these casts showed moduli of rupture of over 50 tons per square inch, moduli of elasticity of over 20×10^6 lb. per square inch, and Brinell hardness values of over 500.—*December 13th*, 1934.

MISCELLANEOUS.

421,105. May 4th, 1934.—VALVES, E. K. Erwes, 139, Hohe Strasse, Dortmund, Germany.

This invention relates to valves for fluid pressure supply pipes of the type in which the valve closes automatically on the

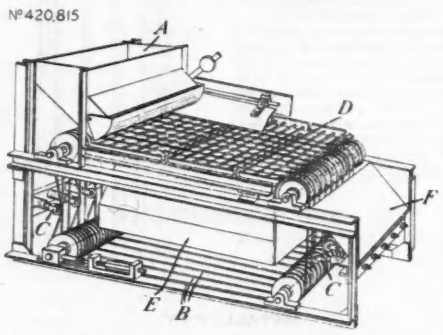
removal or disconnection of a coupling member, and in which eddy currents are reduced and pressure losses are small. The valve comprises a cylindrical closure member having a conical or streamlined head B, below which is provided a washer A made of rubber or similar material. To the conical head B is attached a hollow cylindrical stem D, which acts as a guide and is provided at or near the end adjacent the head B with passages C. The stem D, which carries the conical head B, is resiliently mounted in the interior of a nipple E and, in its closed position, is acted upon by the pressure of a spring F and of the pressure



medium in the pipe in such a way that the washer A is pressed against the conical valve seating H. The washer A is of similar conical shape to the seating and the valve therefore makes a tight closure even when the pressure acting on it is small. When the pressure increases the valve is pressed still more tightly against its seating. The valve is only opened when a socket K, which presses against the extension D, is screwed in by the nut M on the nipple E. When this occurs the pressure medium, owing to the shape of the head B, which is relatively narrow and offers little resistance, can flow through the holes C to the pipe without eddies occurring.—*December 13th*, 1934.

420,815. May 8th, 1933.—SCREENING APPARATUS, The Gas Light and Coke Company, 84, Horseferry-road, Westminster, and S. Hay.

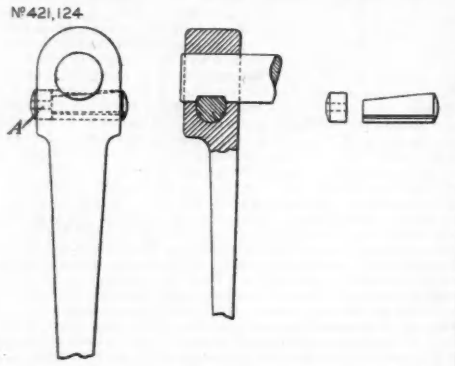
On this screen the material to be classified is drawn forward from the feed hopper A by a series of ropes B passed round guide rollers, as shown. One of these rollers is driven and tensioning



gear is provided at C for the whole collection of ropes. The individual ropes are tensioned by the spring-operated jockey pulleys C C. Beneath the ropes there are bars D, which are built up in changeable units and pass the undersize material to the shoot E. The oversize is thrown off at F.—*December 10th*, 1934.

421,124. June 14th, 1933.—COTTERS, W. T. Williams, Bonson Works, Foundry-lane, Birmingham.

This invention is concerned with such attachments as those of cycle cranks on to their shafts, and aims at reducing excrescences. The cotter is cylindrical and has a flat taper on one side, as usual. It is, however, less in length than the distance



through the hole in the crank. In the open end of the hole there is inserted a plug A, which projects to about the same extent as the exposed end of the cotter. To extract the cotter the plug is driven inwards sufficiently to detach the cotter, and the plug itself is subsequently removed by a small drift.—*December 14th*, 1934.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF ELECTRICAL ENGINEERS.—Grand Hotel, Harrogate. Dinner and dance. 8 p.m.

INST. OF ELECTRICAL ENGINEERS: N.-EASTERN STUDENTS.—Armstrong College, Newcastle-upon-Tyne. "Stray Losses in Synchronous Electrical Machinery," Mr. P. Richardson. 7.15 p.m.

INST. OF FUEL.—At British Industries House Club, Oxford-street, W.1. Discussion, "The Cost of Production, Transport, and Distribution, Per Therm of Various Fuels Relative to the Prices Paid by Users." 6.30 for 7 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. "The Care of Modern Steam Generating Plant from the Water Side," Mr. R. J. Glinn. 6 p.m.

INST. OF STRUCTURAL ENGINEERS: MIDLAND COUNTIES BRANCH.—James Watt Memorial Inst., Birmingham. "The Deterioration of Reinforced Concrete," Mr. A. Ashworth. 6.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Some Pump Problems," Mr. W. E. W. Millington. 7.30 p.m.

MANCHESTER ASSOC. OF ENGINEERS.—The Engineers' Club, Manchester. "Colloidal Treatment of Boiler Feed Water," Mr. J. S. Merry. 7.15 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—Mining Institute, Newcastle-upon-Tyne. "Relation of Fatigue to Modern Engine Design," Messrs. R. A. MacGregor, W. S. Burn, and Professor Frederic Bacon. 6 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse by Sir Richard Livingstone. 9 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "The Industrial Progress of Mysore," Mr. C. R. Rao Sahib. 4.30 p.m.

SATURDAY, JAN. 26TH.

INST. OF CIVIL ENGINEERS.—Students' afternoon visit to the National Physical Laboratory, Teddington.

MONDAY, JAN. 28TH.

INST. OF CIVIL ENGINEERS: BELFAST AND DISTRICT ASSOC.—Physics Lecture Theatre, Queen's University, Belfast. "The Silent Valley Reservoir," Mr. G. McIldowie. 5.45 for 6.30 p.m.

INST. OF ELECTRICAL ENGINEERS: N.E. CENTRE.—Armstrong College, Newcastle-upon-Tyne. "The Removal of Smoke and Acid Constituents from Flue Gases by a Non-Effluent Water Process," Dr. J. L. Pearson, Messrs. G. Noneebel, and P. H. Ulander. 7 p.m.

INST. OF MECHANICAL ENGINEERS: GRADUATES' SECTION.—Storey's-gate, S.W.1. "Some Deduction from Available Information on Dust Collecting," Mr. W. Lennon. 6.45 p.m.

TUESDAY, JAN. 29TH.

HULL CHEMICAL AND ENGINEERING SOC.—Municipal Technical College, Park-street, Hull. "Construction of Long-span Suspension Bridges," Professor C. E. Inglis, F.R.S. 7.45 p.m.

INST. OF ELECTRICAL ENGINEERS: WIRELESS SECTION.—Informal meeting. Savoy-place, W.C.2. Discussion, "The Cause and Prevention of Valve Failures in Broadcast Receivers," opener Mr. T. E. Goldup. 5.30 for 6 p.m.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "Prevention of Fires on Passenger Ships (Automatic Fire Fighting)," Mr. George E. Taylor. 7.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. "Electron Diffraction and its Applications," Professor G. P. Thomson. 5.15 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield, 1. "Twenty Years' Development of the 'Analoid' System of Analyses," Mr. N. D. Ridsdale. 7.30 p.m.

WEDNESDAY, JAN. 30TH.

INST. OF CIVIL ENGINEERS: MANCHESTER AND DISTRICT ASSOCIATION.—Midland Hotel, Manchester. Annual dinner. 6.30 for 7 p.m.

THURSDAY, JAN. 31ST.

INST. OF LOCOMOTIVE ENGINEERS.—At Inst. of Mechnical Engineers, Storey's-gate, S.W.1. "Brakes for Streamlined Railway Vehicles," Mr. W. F. McDermid. 6 p.m.

INST. OF MARINE ENGINEERS: JUNIOR SECTION.—The Minories, E.C. Film display and lecture, "The Sheffield Works of the English Steel Corporation, Ltd.," Mr. C. H. Dolphin. 7 p.m.

INST. OF STRUCTURAL ENGINEERS: YORKSHIRE BRANCH.—Hotel Metropole, Leeds. "Modern Methods of R.C. Construction," Mr. H. N. Broughton. 7 p.m.

FRIDAY, FEB. 1ST.

INST. OF ELECTRICAL ENGINEERS: N.-EASTERN CENTRE.—Grand Assembly Rooms, Barras Bridge, Newcastle-upon-Tyne. Annual dinner and dance. 7 p.m.

INST. OF MINING ENGINEERS.—At Rooms of Geological Soc., Burlington House, W.1. Annual general meeting. Presidential Address by Mr. Laurence Holland, 11.15 a.m. "Silicosis in British Coal Mines," Dr. S. W. Fisher, 2.15 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. Informal talk on "The Design and Erection of the Great Wheel at Earl's Court," Mr. H. Cecil Booth. 7.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse, "The Approach to the Absolute Zero of Temperature," Dr. F. Simon. 9 p.m.

SATURDAY, FEB. 2ND.

INST. OF BRITISH FOUNDRYMEN: LANCS. BRANCH.—Grand Hotel, Manchester. Annual whist drive, dinner, and dance.

YORKSHIRE EDUCATIONAL ASSOCIATION FOR THE BUILDING INDUSTRY.—College Hall, Technical College, Bradford. Conference, "Science and the New Building Materials," opener Dr. R. E. Stradling. 2.30 p.m.

SUNDAY, FEB. 3RD.

INST. OF ELECTRICAL ENGINEERS: N.-EASTERN STUDENTS.—Visit to the Paramount Theatre, Newcastle-upon-Tyne. 11 a.m.

TUESDAY, FEB. 5TH.

ILLUMINATING ENGINEERING SOC.—Trocadero Restaurant, London. Annual dinner and dance. 7 for 7.30 p.m.

INST. OF AUTOMOBILE ENGINEERS.—James Watt Memorial Inst., Birmingham. "The Utilitarian Aesthetics of Automobile Body Design," Mr. W. O. Kennington. 8 p.m.

WEDNESDAY, FEB. 6TH.

INST. OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Visit to West Middlesex main sewerage and sewage disposal works. Leave New-street, Birmingham, 8.40 a.m.

INST. OF ELECTRICAL ENGINEERS: WIRELESS SECTION.—Savoy-place, W.C.2. "Continuously Evacuated Valves and their Associated Equipment," Mr. C. R. Burch and Dr. C. Sykes. 6 p.m.

SOC. OF GLASS TECHNOLOGY: LONDON SECTION.—Visit to the Glass Bottle Works of Lewis and Towers, Ltd., Hartwell-street, Dalston Junction, E.8. 7.30 p.m.

FRIDAY, FEB. 8TH.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Informal meeting. "Centrifugally Cast Iron," Mr. J. E. Hurst. 7 p.m.

INST. OF METALS.—The University, Sheffield. "The Manufacture of Pewter," Captain F. Orme. 7.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "The Design and Equipment of Photo-elastic Laboratories, with a Brief Account of the Elements of Photo-elasticity," Professor E. G. Coker. 7.30 p.m.

ROYAL AERONAUTICAL SOC.—At Inst. of Electrical Engineers Savoy-place, W.C.2. "Ice Formation in Carburettors and Induction Systems," Mr. W. C. Clothier. 6.30 p.m.

MONDAY, FEB. 11TH.

INST. OF ELECTRICAL ENGINEERS.—Savoy-place, W.C.2. Discussion on "The I.E.E. Wiring Regulations (Tenth Edition)," Opener, Mr. H. J. Cash. 6.30 for 7 p.m.

INST. OF METALS.—At 39, Elmbank-crescent, Glasgow. "Recent Developments in Electric Furnaces for Non-ferrous Metals," Mr. A. G. Robiette. 7.30 p.m.

TUESDAY, FEB. 12TH.

INST. OF METALS.—James Watt Memorial Inst., Birmingham. Symposium on Pickling Processes. 7 p.m.

INST. OF METALS.—Armstrong College, Newcastle-upon-Tyne. "Melting Furnaces for Non-ferrous Metals," Mr. G. L. Cassidy. 7.30 p.m.

INST. OF METALS.—Y.M.C.A., Swansea. "Design of Rolling Mills for Cold Rolling of Metals, both Ferrous and Non-ferrous," Mr. C. E. Davies. 6.15 p.m.

THURSDAY, FEB. 14TH.

INST. OF AUTOMOBILE ENGINEERS.—At Merchant Venturers' Technical College, Bristol. "A Study of Road Performance," Mr. Maurice Platt. 7 p.m.

INST. OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION; INST. OF MECHANICAL ENGINEERS: MIDLAND BRANCH; and INST. OF ELECTRICAL ENGINEERS: SOUTH MIDLAND CENTRE.—Annual joint meeting. Central Hall, Corporation-street, Birmingham. "The Houston Mount Everest Flight," by the leader of the expedition, Air Commodore P. F. M. Fellowes, D.S.O. 7 p.m.

INST. OF METALS.—Joint meeting with the Electro-Depositors' Technical Soc., at Rooms of Soc. of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W.1. "The Protection of Metals by Coatings," Dr. W. H. J. Vernon. 7.30 p.m.

FRIDAY, FEB. 15TH.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. Lecture, "The Application of Proof Stress to Modern Aircraft Material," Mr. H. J. Alpe. 7.30 p.m.

MONDAY, FEB. 18TH.

INST. OF METALS.—Joint Meeting with Inst. of Automobile Engineers, at 39, Elmbank-crescent, Glasgow. "Recent Advances in Metallurgy," Dr. A. McCance. 7.30 p.m.

WEDNESDAY, FEB. 20TH.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "Water Supplies from Underground Sources," Lieut.-Colonel J. D. Restler. 8 p.m.

FRIDAY, FEB. 22ND.

RAILWAY CLUB.—At Royal Scottish Corporation, Fetter-lane, E.C.4. Annual general meeting, Presidential Address, "Eastern Counties Railway." 7.15 p.m.

CATALOGUES.

ALFRED HERBERT, Ltd., Coventry.—"The Book of the Tangic Diehead."

DORMAN, LONG AND CO., Ltd., Middlesbrough.—"Analyses of Coal and Coke."

RUSTON AND HORNSBY, Ltd., Lincoln.—A descriptive brochure of oil-engined locomotives.

BAKELITE, Ltd., 68, Victoria-street, S.W.1.—A new booklet, "Bakelite Gears and Pinions."

SELSON MACHINE TOOL COMPANY, Ltd., 23, Abbey House, S.W.1.—1935 catalogue of machine tools.

PULSOMETER ENGINEERING COMPANY, Ltd., Reading.—List 0710 of purification plant for swimming baths.

DONOVAN ELECTRICAL COMPANY, Ltd., Northcote-road, Stechford, Birmingham, 9.—Electrical Supplies List 3491.

GEO. ANGUS AND CO., Ltd., St. John's Works, Newcastle-on-Tyne.—A small brochure on rawhide and "Durangus" silent gears.

STOCKTON CHEMICAL ENGINEERS AND RILEY BOILERS, Ltd., Stockton-on-Tees.—Loose-leaf catalogue of Riley boilers of all types.

BRITISH ALUMINIUM COMPANY, Ltd., Adelaide House, King William-street, E.C.4.—"Aluminium Coachwork for Passenger Vehicles."

DAVID BROWN AND SONS (HUDD.), Ltd., Huddersfield.—Publication No. F600–5, dealing with automobile gears and gear units.

CAMBRIDGE INSTRUMENT COMPANY, Ltd., 45, Grosvenor-place, S.W.1.—Folder No. 47 on pressure and draught indicators and recorders.

J. BLAKEBOROUGH AND SONS, Ltd., Brighouse, Yorks.—A booklet describing the firm's screening plant of the travelling, revolving, and fixed screen types.

BRUCE PEEBLES AND CO., Ltd., Edinburgh, 5.—Nine descriptive leaflets illustrating the constructional features of the new range of industrial type A.C. motors.

BRITISH THOMSON-HOUSTON COMPANY, Ltd., Rugby.—Pamphlet A.G.494, dealing with electric equipment particularly applicable to metal and woodworking machine tools.

SANKEY OIL SYSTEMS, Ltd., Brettenham House, Strand, W.C.2.—A folder illustrating the firm's automatic coal stoker made in three types, the hopper, direct and radial feed.

JAMES KEITH AND BLACKMAN, Ltd., 27, Farringdon-avenue, E.C.4.—Publications K129, on drying plants; G57, on rotary compressors; and G117, on automatic mixture control.

SCAMMELL LORRIES, Ltd., 52–54, High Holborn, W.C.1.—A brochure entitled "Civic Pride in Civic Service," dealing with the various applications of the firm's mechanical horse.

TRUSSED CONCRETE STEEL COMPANY, Ltd., Thames House, Millbank, S.W.1.—Particulars of "Solcheck" roofing slabs used for the protection of flat asphalted roofs from the sun's heat.

G. AND J. WEIR, Ltd., Cathcart, Glasgow.—Catalogue Section S, describing "Monotype" air pumps, "Paragon" air pumps, "Maxivac" air ejectors, and turbine and electrically driven condensate pumps.

REDPATH, BROWN AND CO., Ltd., 2, St. Andrew-square, Edinburgh, 2.—A supplement to the firm's 1928 "Handbook of Structural Steel Work," containing selected tables of safe loads and properties for the revised sections of the British standard steel sections for structural purposes.

LEIPZIG TECHNICAL SPRING FAIR.—We are informed that enquiries for the reservation of space at the Engineering and Building Fair at Leipzig, which will take place from March 3rd to March 10th next, are being received in considerably larger numbers than in previous years. All the space in the main Machine Tool Hall and the Electrotechnical Hall has been booked up and in the group of general mechanical engineering the amount of space rented for the Spring Fair is already considerably in advance of that at the same time in former years. The increase is especially noticeable in the department of Diesel Engines and Foundry Machinery. The hall housing the Building Trade Fair will have no free space left, and we note that the manufacturers of gas appliances will arrange a special exhibition on a large scale in this hall.